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## CONFLAGRATIONS OF WORLD'S FAIR BUILDINGS.

THE World's Fair grounds have been the scene of several disastrous conflagrations. The first and most notable was that of July 10, 1893, when the cold storage building was destroyed, with the loss of fifteen lives.

This fire deprived the Exposition of a beautiful building and an interesting exhibit as well. Considering the frail method of construction of the buildings in the Columbian Exposition, it is fortunate this was the only fire of importance during the Exhibition. As a safeguard, a special fire department was organized and equipped with the latest appliances for fighting fire, and the system of water supply and fire alarms reflected the highest credit upon the engineers in charge. Every possible care was used to prevent fires and to extinguish them quickly whenever they occurred.

The Manufactures building, with its almost inestimable treasures of art and industry, was patrolled from the roof to the vaults beneath the floors, by Columbian guards whose faithfulness to duty was assured by electrical signaling and registering devices. After the Fair closed for the first few weeks the fire precautions were unabated, but gradually the number of guards decreased until at last only a handful remained while the grounds were thrown open to the public. The World's Columbian Exposition Company passed out of control and the management was assumed by the South Park Commissioners. The result of this lack of adequate fire protection has been a most extraordinary series of fires, the origin of which is believed to have been incendiary. The motive for these crimes is variously stated. By some it is thought the dealers in second-hand building materials have had a hand in it, as they are interested in hurrying up the South Park Commissioners in winding up Jackson Park affairs and the sale of the buildings. Others suppose that tramps fired the buildings, either by accident or out of pure mischief. It would be strange if some of the fires were not due to individuals who take delight in seeing a blaze, when it is remembered that it was seriously proposed by some of the Chicago engineers and architects, before the close of the Fair, to have the buildings burned up singly to the delight of thousands of excursionists.

On January 8 occurred a fire in which the Peristyle, Music Hall and Casino were destroyed and the Manufactures building injured. At first this fire was supposed to have entailed a loss of $1,500,000, but this sum was afterward largely reduced. One life was lost. The fire started in the Casino and moved north along the Peristyle, burning en route the beautiful Columbian Arch, with its splendid quadriga, representing the "Triumph of Columbus." Then the Music Hall perished in turn and the flying firebrands soon set the huge roof of the Manufactures building on fire. The extreme risk connected with fighting the conflagration from such a dizzy height (300 feet), enveloped in smoke and flying sparks, can be seen by reference to our engraving. At length the fire was subdued, but the glory of the Court of Honor had departed forever.

On February 14, a fire started at 11 A. M., in the colonnade between the Agricultural building and Machinery Hall. The whole colonnade was destroyed, but the buildings on either side were saved. On February 18 the Illinois State building was partly destroyed by fire. This fire, like the preceding ones, was believed to be of incendiary origin. The chief danger connected with this fire was the risk to the Field Columbian Museum, the collections of which are now installed in the Art building. This edifice was fortunately saved. On February 24, fire was discovered in the dome of the Agricultural building at 7 A. M., and soon the whole roof was blazing. The destruction of the dome has rendered the beautiful building an eyesore. The Court of Honor now little resembles that glorious creation which astonished all beholders.

What little of the beauty remained in Jackson Park after the close of the Fair has been destroyed, and the sooner the dangerous structures which are a menace to life and property are removed, and the park restored to its pristine state, the better.

BURNING OF THE WORLD'S FAIR BUILDINGS, CHICAGO.

MORTALITY AMONG HOSPITAL NURSES.—A healthy girl of seventeen, devoting herself to hospital nursing, dies on the average twenty-one years sooner than a girl of the same age moving among the general population, and a hospital nurse at the age of twenty-five has the same expectation of life as a person at the age of fifty-eight in the ordinary community.

## THE ART OF BOOK AND NEWSPAPER ILLUSTRATION.*

By HENRY BLACKBURN.

*Lecture I.*

EIGHTEEN years ago, in this room, the general question was discussed "whether, in the matter of book and newspaper illustration, we are really 'keeping pace with the times;' whether those who provide the illustrations, which are tossed from steam printing presses at the rate of several thousand an hour, are doing the best work they can." The meeting was largely attended by experts, and the general conclusion arrived at was, that much remained to be done.

Thus in 1875 it was admitted, almost without dissent, that the system of illustrating books of travel and scientific research by means of wood engravings was "too elaborate and costly;" that, in consequence, there was much valuable material that never saw the light, and that in the case of news the public was continually deprived of what it would most care to see.

In the illustration of newspapers, it was further argued that there should be a clearer distinction between fact and fiction, between illustrated news and pictures. The exact words may be thought worth repeating:

"In the production of illustrations we have arrived at great proficiency, and from London are issued the best illustrated newspapers in the world. But our artistic skill has led us into temptation, and by degrees engendered a habit of making pictures when we ought to be recording facts. We have thus, through our cleverness, created a fashion and a demand from the public for something which is often elaborately untrue.

"Would it then be too much to ask those who cater for (and really create) the public taste, that they should give us one of two things, or rather *two things* in our illustrated papers, the real and the ideal?

"First. Pictorial records of events in the simplest and truest manner possible.

"Second. Pictures of the highest class that can be printed in a newspaper.

* Three lectures delivered before the Society of Arts, London, December, 1893. From the *Journal* of the Society.

"Here are two methods of illustration which only require to be kept distinct, each in its proper place, and our interest in them would be doubled. We ask first for a record of news and then for a picture gallery; and to know, to use a common phrase, *which is which.*"

At the time referred to, drawing on the wood block and engraving was almost universal—instantaneous photography was in its infancy, "process blocks," that is to say, mechanical engraving, was very seldom employed, and (for popular purposes) American engraving and printing was making great strides.

Let us now glance at some of the changes which have taken place in illustration (bridging over a distance of nearly twenty years), and consider the work of the illustrator, the photographer, and the maker of blocks, as presented in books and newspapers at the end of 1893; speaking principally of topical illustrations, on which so many thousand people are now engaged.

It may seem strange at first sight to include "newspapers" in the title of these lectures; but the fact is that the weekly newspapers, with their new appliances for printing, and in consequence of the cheapness of good paper, are now competing with books and magazines in the production of illustrations which a few years ago were only to be found in books. The illustrated newspaper is one of the great employers of labor in this field, and distributers of the work of the artist in black and white, and in this connection must by no means be ignored. The post office carries a volume of 164 pages (each 16 by 22 inches), weighing from two to three pounds, for a halfpenny. It is called a "weekly newspaper," but it contains, sometimes, 100 illustrations, and competes seriously with the production of illustrated books.

In the next lecture we shall see how the illustrations of one number of an illustrated newspaper are produced; what part the original artist has in it, what part the photographer, what part the wood engraver.

It was time, perhaps, that the "Society for the Encouragement of Arts, Manufactures, and Commerce" should take into consideration the state of book illustration in the present day. The words which head the proceedings of this society are singularly applicable; the "Art, Manufacture, and Commerce" of a book is well worth examining.

The modern publisher, it may be said without offense, understands the manufacture and the commerce of a book better than the art in it. And how should it be otherwise? The best books that were ever produced, from an artistic point of view, were inspired and designed by students of art and letters, men removed from the commercial scramble of life, and to whom an advertisement was a thing unknown! The ordinary education of a publisher, and the multitude of affairs requiring his attention, unfit him for the task of deciding whether an illustration is good or bad; or how far—when he cheapens the production of his book by using photographic illustrations ("snap shots" from nature)—he is justified in calling it "art."

It would be difficult, I think, to point to a period when so much bad work was produced as at present. The causes are not far to seek. As matters stand at present, the beautiful processes for the reproduction of drawings for the type press are scarcely understood by the majority of artists, publishers, authors or critics. It is the misuse of these processes which is dragging our national reputation in the mire. Our best artists have neither the time nor the inclination to make themselves acquainted with the methods, and it is hardly to be expected that a reviewer who has a pile of illustrated books to pronounce upon should know the reason of the failures that he sees before him. Thus the public is grievously misled by those who should be its guides as to the value and importance of the new systems of illustration.*

The deterioration in the character of book illustration in England is a serious matter, and public attention may well be drawn to it. The first and most serious difficulty to contend against is the comparatively low estimate of this class of work, and the competition of photographs. The second is the want of good technical education in this direction. Students leave art schools by hundreds not properly equipped for the business of life. The business of many will be to contribute in some form to the making of pictures and designs to be multiplied in the press; and, in order to learn the technique and obtain employment, some of the most promising pupils have to fall into the ways of the producers of cheap illustrations, Christmas cards, and the like. On the other hand, a knowledge of the mechanical processes for reproducing drawings (as it is being pressed forward in technical schools) is leading to disastrous consequences, as may be seen on every railway bookstall in the kingdom.

It is the special purpose of these lectures to inquire into the conditions under which process illustrations (to use the common phrase) are now produced, and to see how far, and in what way, we may obtain the best results.

It cannot have escaped observation that in the various lectures, demonstrations, and discussions held under the auspices of the Society of Arts, on the subject of book illustration, little has been said about the illustrator, upon whom so much in the future will depend. In May, 1882, Mr. J. Comyns Carr gave three Cantor lectures on "Book Illustration" (old and new) in which the subject was treated historically, and in which the wood engraver's art was most considered. In 1878, and in 1884, Mr. Thomas Bolas gave several Cantor lectures with practical demonstrations: in 1878, on "The Application of Photography to Printing Surfaces," and 1884, on "Improvements in Photo-Mechanical Printing Processes." And during the last ten years several excellent papers have been read on Wednesdays on artistic and decorative illustration, notably by Mr. Walter Crane and Mr. L. F. Day; also one in 1891, when the whole *modus operandi* of the production of a daily illustrated newspaper was made plain before you by Mr. Carmichel Thomas, of the *Graphic*.

All these papers, valuable as they are for reference and help, leave, I think, much to be said as to the illustrations of to-day from the artists', the authors', and the publishers' point of view.

First. As to line drawing for reproduction by the type press. It cannot be sufficiently borne in mind—I am speaking now to students who are not intimate with the subject—that to produce with pure black lines the quality and effect of lines in which there is some gradation of tone, is no easy matter, especially to those accustomed to the wood engraver as the interpreter of their work. Sir John Tenniel, Mr. Du Maurier, and Mr. Sambourne, not to mention others on the *Punch* staff, have been accustomed for many years to draw for wood engraving, and would probably still prefer this method to any other.

But the young illustrator has to learn the newer methods, and how to get his effects through direct photo engraving. What may be done by the latter is sufficiently demonstrated in the line drawings which appear in our newspapers, magazines, and books; I speak of those which are well printed and on good paper. Many German and French periodicals teach us what to admire and what to avoid. I am referring only to line drawing in this first lecture, because it is the only process in relief which may be said to give any certain results, leaving the consideration of other developments of process work until next week. Line drawings are now reproduced on zinc blocks fitted for the type press at a cost of less than sixpence the square inch for large blocks. The first condition for this process is to draw in pure black lines on Bristol board, or smooth white paper; the process of reproduction will be explained further on.

Let us glance first at the ordinary hand-book teaching, and see how far it is useful to the illustrator of to-day. The rules laid down as to the methods of line work, the direction of lines for the expression of certain textures, "cross hatching," etc., are, if followed too closely, apt to lead to hardness and mannerism in the young artist, which he will with difficulty shake off. On these points, Mr. Robertson,* the well known painter and etcher, writing seven years ago, says well:

"The mental properties of every line drawn with pen and ink should be original and personal; . . . this strong point is sure to be attained unconsciously, if an artist's work is simple and sincere, and *not the imitation of another man's style.*"

"When the question arises as to what examples a beginner should copy who wishes to practice the art of pen and ink drawing, the difficulty will be to select from the great and varied stores of material that are everywhere to his hand. All steel and copper plate engravings that have been executed in line, and all wood engravings, are within the possible range of pen and ink drawing. I hold, however, that much time should not be occupied in the imitative copying of prints; only, indeed, so much as enables the student to learn with what arrangement of lines the different textures and qualities of objects may be best rendered."

There are, roughly, two methods of obtaining effect with a pen—one by few lines, laid slowly; and the other by many lines, drawn with rapidity. If the intention is to see what effect may be obtained with comparatively few lines deliberately drawn, we may refer to the woodcuts after Albert Durer and Holbein and the line engraving of Marc Antonio. The engraved plates by Durer furnish excellent examples of work, with more and finer lines than his woodcuts. "Some of the etchings of Rembrandt are examples of what may fairly be reproduced in pen and ink, but in them we find the effect to depend upon innumerable lines in all directions. In the matter of landscape the etched plates by Claude and Ruysdael are good examples for study, and in animal life we may refer to those of Paul Potter and Dujardin."

Thus, for style, for mastery of effect and management of line, we must go back to the old masters, to work produced generally in a reposeful life, to which the younger generation are strangers. But the mere copying of other men's lines is of little avail without mastering the principles of the art of line drawing. The skillful copies, the *facsimiles* of engravings and etchings drawn in pen and ink, which are the admiration of the young artist's friends are of little or no value in deciding the aptitude of the student. The following words are worth placing on the walls of every art school: "Proficiency in copying engravings in *facsimile*, far from suggesting promise of distinction in the profession of art, plainly *marks a tendency to mechanical pursuits*, and is not likely to be acquired by any one with much distinctive feeling for the arts of design."

There is much truth and insight in this remark.

In line work, as now understood, we are going back in a measure to the point of view of the missal writer and the illuminator, who, with no thought of the possibilities of reproduction, produced many of his decorative pages by management of line alone (I am speaking of the parts of his work in which color was not employed). No amount of patience, thought, and labor was spared for this one copy. What would he have said if told that in centuries to come this line work would be revived in its integrity, with the possibility of the artist's own lines being reproduced 100,000 times, at the rate of several thousand an hour? And what would he have thought if told that out of thousands of students in centuries to come, a few, a very few only, could produce a decorative page; and that few could be brought to realize that a work which was to be repeated, say a thousand times, was worthy as much attention as his ancestors gave to a single copy?

On the principle that "everything that is worth doing is worth doing well" and on the assumption that the processes in common use—I purposely omit mention of the olden systems of drawing on transfer paper, and drawing on waxed plates, without the aid of photography; also of photo-lithography: these have been dealt with in previous papers—are worth all the care and artistic knowledge which can be bestowed upon them, we would press upon young artists especially the importance of study and experiment in this direction. As there is no question that "the handwork of the artist" can be seen more clearly through mechanical engraving than through wood engraving, it behooves him to do his best. And as we are substituting process blocks for wood engraving in every direction, so we should take over some of the patience and care which were formerly given to book illustrations.

We cannot live, easily, in the cloistered silence of the past, but we can emulate the deliberate and thoughtful work of Mantegna, of Holbein, of Albert Durer, and the great men of the past, who, if they were alive to-day, would undoubtedly have preferred drawing for process to the labor of etching and engraving; and, if their work was to be reproduced by others, they would have perceived, what it does not require much insight in us to realize, that the individuality of the artist is better preserved by making his own lines than by those of the engraver. To do this successfully in these days, the artist must give his best and most deliberate (instead of his hurried and careless) drawings to the processes; founding his style, to a limited extent, it may be on the work of the old engravers, but preserving his own individuality.

But we must not slavishly copy sketches by the old masters, which were never intended for reproduction. We may learn from the study of them the power of line to express character, action, and effect, we may learn composition sometimes, but not often, in a sketch.

As to copying the work of living artists, it should be remembered that the manner and the method of a line drawing is each artist's property, and the repetition of it by others is injurious to him. It would be an easy method indeed if the young artist, fresh from the schools, could, in a few weeks, imitate the mannerism, say of Sir John Gilbert, whose style is founded upon the labor of fifty years. There is no such royal road.

But for the illustrator by profession there seems no artistic leisure in 1893, no time to do anything properly in this connection.

"It is a poor career, Blackburn," said a well known newspaper illustrator to me lately (an artist of distinction and success in his profession, who has practiced it for twenty years); "you seldom give satisfaction—not even to yourself."

"It is an *ideal career*," says another, a younger man, who is content with the more slapdash methods in vogue to-day, and with the income he receives for them.

There is another point to notice. The education of the illustrator in these days means much more than mere art training. The tendency of editors of magazines and newspapers is to employ those who can write as well as draw. This may not be a very hopeful sign from an art point of view, but it is a condition of things which we have to face.

In sketches of society the education and standing of the artist has much to do with his success. Mr. Du Maurier's work in *Punch* may be taken as an example of what I mean, combining excellent art with knowledge of society. His clever followers and imitators lack something which cannot be learned in an art school.

Much as we may desire to see a good artist and a good *raconteur* in one man, the combination will always be rare; and those editors who seek for it are often tempted to accept inferior art for the sake of the story. I mention this as one of the influences affecting the quality of illustrations of an ephemeral or topical kind, which should not be overlooked.

It should be borne in mind that, in drawing for reproduction by any of the mechanical processes (either in wash or in line, but especially the latter), there is more strain on the artist than when his work was engraved on wood, and the knowledge of this has left process drawing principally in the hands of the younger men. They will be older by the end of the century, but not as old then as some of our best and experienced illustrators who keep to wood engraving.

I am touching now upon a difficult and delicate part of the subject, and must endeavor to make my meaning clear. The illustrations in *Punch* have, until lately, all been engraved on wood (the elder artists on the staff not taking kindly to the processes), and the style and manner of line we see in its pages is due in great measure to the influence of the wood engraver.*

This refers to *facsimile* work, but the engraver, as we know, also interprets wash into clean lines, helps out the timid and often unsteady draughtsman, and in little matters puts his drawing right.

Now the wood engraver was apprenticed to his art, and after long and laborious teaching, mastered the mechanical difficulties. If he had the artistic sense he soon developed into a master engraver and illustrator, and from crude and often weak and inartistic drawings he produced illustrations full of tone, quality and beauty. (He does so still, to a limited extent, as many an author knows.)

From very slight material handed to him from a publisher the wood engraver would evolve (from his inner consciousness so to speak) an elaborate and graceful series of illustrations, drawn on the wood block by artists in his own employ, who had special training, and knew exactly how to produce the effects required. The system often involved much care and research for details of costume, architecture and the like, and, if not very high art, was at least well paid for, and appreciated by the public. I am speaking of the average illustrated book say of twenty years ago, when it was not an uncommon thing to spend £500 or £600 on the engravings of a book. Let us hope that the highest kind of wood engraving will always find a home in England.

I do not think the modern illustrator realizes how much depends upon him in taking the place, so to speak, of the wood engraver. But the interpreting of tone into line fitted for the type press, to which the wood engraver gave a lifetime, will devolve more and more upon him. We cannot keep this too continually in mind, for, in spite of the limitations in mechanically produced blocks (as compared with wood engraving) in obtaining delicate effects of tone in line, much can be done in this direction in which the engraver has no part. That it is possible, by the common processes, to obtain effects almost equal to wood engraving, may be seen in the illustrations to Mr. Andrew Lang's

* There seems but one rule of criticism in this connection. If a book illustration comes out coarsely and (as is often the case) almost smudge, the process is blamed, when the drawing or photograph may have been quite unsuitable for the process employed.

* "The Art of Pen and Ink Drawing," by H. R. Robertson. London: Winsor & Newton, 1886.

* One of the most accomplished of English painters told me the other day that when he first drew for illustration, the wood engraver dictated the angle and style of cross hatching, etc., so as to fit the engravers' tools.

"Blue Poetry Book," by Mr. Lancelot Speed, in which many technical experiments have been made, including the free use of white lining by process.* But more notably, from an art point of view, are the illustrations, produced lately at the Birmingham Municipal School of Art, by process drawing, one of which I will show you on the screen.

All this, you will observe, points to a higher use of the process block than is generally allowed, to something, in short, very differe t to the thin sketchy outlines and scribbles which are considered the proper functions of the "pen and ink artist."

But "the values" are scarcely ever considered in this connection. Mr. Hamerton makes a curious error in his "Graphic Arts," where he advocates the use of the "black blot in pen drawing," arguing that as we use liberally white paper to express air and various degrees of light, so we may use masses of solid black to represent many gradations of darkness. A little reflection will convince any one that this is no argument at all.

The ideal illustration by mechanical means is, where the principles of line engraving are followed to the utmost limits of pen and ink drawing, where the lines of the drawing do not intrude upon the effect—a drawing which can be reproduced with the least touching or "rouletting" on the block, and which requires the least "overlaying" and "making ready" on the part of the printer.

Mr. Ruskin's advice, in his "Elements of Drawing," as to how to lay flat tints by means of pure black lines (although written many years ago, and before mechanical processes of reproduction were in vogue) is singularly applicable and useful to the student of today, especially where he reminds him that, "if you cannot gradate well with pure black lines, you will never do so with pale ones."

To "gradate well with pure black lines" is, so to speak, the whole art and mystery of drawing for the photo-zinc process, of which one London firm alone turns out more than a thousand blocks a week.

As to the amount of reduction that a drawing will bear with advantage in reproduction it cannot be sufficiently widely known, that in spite of rules laid down, there is no rule about it.

Mr. Emery Walker, of the firm of Walker & Boutall, who has had great experience in the reproduction of illustrations and designs from the old books and manuscripts, will tell you that very often there is no reduction of the original; and he will show reproductions in photo-relief of engravings and drawings of the same size as the originals, the character of the paper, and the color of the printing also, so closely imitated, that experts can hardly distinguish one from the other.

On the other hand the value of reduction, for certain styles of drawing especially, can hardly be overestimated. On these walls you may see drawings reduced to one-sixteenth the area of the original, some even more, and results obtained which could be achieved by no other means

Again I say "there is no rule about it." In the course of years, and in the reduction to various scales of thousands of drawings by different artists, to print at the type press, my experience is that *every drawing has its scale, to which it is best reduced.*

A word as to sketching in line from life ready for reproduction on a process block. The system is, I know, followed by a few illustrators for newspapers (whose names might easily be mentioned), who by incessant practice have become proficient. They have special ability for this kind of work, and their manner and style is their capital and attraction.

But to attempt to teach rapid sketching in pen and ink is beginning at the wrong end, and is fatal to good art: it is like teaching the principles of pyrotechnics while fireworks are going off. And yet we hear of prizes given for rapid sketches to be reproduced by the processes. Indeed, I believe that is the wrong road; the baneful result of living in high pressure times. Imagine any artist of the past—you might almost say any artist of the present—consenting to such a system of education.†

Sketching from life is, of course, necessary to the student, but it should be done in pencil or whatever medium is easiest at the moment; but the lines for reproduction require thinking about, thinking what to leave out and how to interpret the gray of a pencil, or the tints of a brush sketch in the fewest lines. Thus, and thus only, the student learns the art of leaving out, "the value of a line."

The tendency of modern illustrators is to imitate somebody; and in line drawing for the processes, where the artist, and not the engraver, has to make the lines, imitation of some man's method is almost inevitable.

Let me quote an instance. The style of the late Charles Keene is imitated in more than one journal at the present time, the artists catching his method of line more easily than the higher qualities of his art, his *chiaroscuro*, his sense of values and atmospheric effect. I say nothing of his pictorial sense and humor, for they are beyond imitation. It is the husk only we have presented to us.

As a matter of education and outlook for the younger generation of illustrators, this imitation of other men's lines deserves our special consideration. Nothing is easier in line work than to copy from the daily press.

* Mr. Robertson's hand book is here a little out of date, where he says: "Wood cuts in which white lines play a prominent part are obviously unsuited as examples or suggestions for pen and ink work;" but white lines, drawn with pen or brush, are continually used in process work.

† Mr. Joseph Pennell's wonderful pen and ink drawings from the towers of Notre Dame are the exception which prove the rule.

## THE BOILING OF LINSEED OIL.‡

WHEN raw linseed oil is heated to from 450 to 500° F. with a small addition of litharge, red lead, manganese or some other metallic salt, which by catalytic action can set up oxidation in the oil, it becomes heavier, dries up more quickly, and leaves behind a coating which is of a more highly lustrous character than is the coating from raw linseed oil. On these phenomena is based the production of what is known as "boiled" linseed oil. The process of boiling may be carried out in two ways—the first or oldest method is by direct fire heat in iron boilers, the second or newest process is by means of steam heat in suitably constructed boilers. In no case is the process at all a difficult one, and yet care must be exercised if a satisfactory result is to be obtained.

*Boiling by Direct Fire Heat.*—This is carried out in an iron boiler made like a common wash house boiler, or, better still, of boiler plate with cylindrical sides and a hollow bottom riveted on the sides, as the bottom is the part which is usually worn away long before the sides are, this method of construction affording an easy way of repairing by putting new bottoms when required. The boiler is set in brick work, so that the fire comes only in contact with the bottom of the boiler; a flue running round the lower third of the boiler serving to carry the heat in an efficient manner to the contents of the boiler. The boiler should be built against the outer wall of the oil-boiling shop, so that the fireplace is fed from the outside, this precaution being necessary for the purpose of avoiding fires. Oil has sometimes a nasty trick of boiling over in an unexpected fashion, and if the fireplace is inside, the oil would be likely to find its way into it, with the result that a fire would occur. The boiler should have a capacity at least twice as great as the quantity of oil it is desired to boil in it. Above the boiler ought to be fixed a ventilating hood to carry off any fumes which may be produced, and which, if allowed to accumulate in the boiling shed, would inconvenience the workmen.

The oil to be boiled is run into the boiler until the latter is about half full, the fire is lighted, and the oil slowly heated. It should be closely watched, because it is in this preliminary heating where the greatest risk of boiling over occurs. Should this happen, the fire must be drawn immediately, and the oil quickly ladled out into another boiler, where it is kept until it has got cold, when it can be restored to the boiler, and the fire again started. A thermometer placed in the oil is washed and the firing regulated so that the heat does not exceed 500 F. There is no advantage to be gained in heating above this, while further there is the disadvantage of the oil becoming charred and thereby discolored. After being kept about two hours at this heat, during which time any water which the oil may contain will have been driven off, the driers are added in small quantities at a time in proportions according to the use to which the resulting boiled oil is to be put. Of litharge about 5 lb. are required for a ton of oil, of red lead about the same amount, of manganese half these quantities are sufficient for an ordinary boiled oil for painters' use, while for making oilcloths or linoleum larger quantities are added The addition of the litharge should extend over a period of two to three hours, the oil being stirred up from time to time during the interval; after the whole of the drier has been added, the boiling should be continued for at least two hours longer, although for a quick-drying heavy-bodied oil three or four hours' boiling may be given with advantage. At the end of that time the fire is drawn and the oil left to cool down, after which it is run into storage tanks to settle, the clear oil is drawn off for use, while the turbid "foots" is run off for other purposes.

*Steam Boiling.*—This method of producing boiled oil was introduced by C. W. Vincent, and has become largely used, it giving, as a rule, a paler oil. than can be obtained by the fire process. It is carried out in a steam-jacketed iron or copper pan; arrangements are provided for agitating the oil during the operation, while a current of air can be sent into the oil during the operation. Into the pan is put the oil; the steam, which is used at a pressure of about 40 lb., is sent into the jacket and the oil heated until a peculiar sickly smell is evolved, the agitator being at work the whole of the time. A small quantity of driers is now added; these are preferably some compound of manganese. The borate is the best, although Hartley recommends using the linoleate, and air is blown through the oil. From time to time more driers are added until the required quantity has been used, the working is carried on for four hours longer, when it is ended and the oil is run off into the storage tanks to settle and clarify.

When lead is used as a drier, some of it passes into the oil in the form of lead linoleate, while some free linoleic acid is formed and acrolein evolved. The lead linoleate imparts to the oil the property of drying with a glossy coating; at the same time it prevents the oil from being used with some bright pigments like cadmium yellow, ultramarine, vermilion, and antimony orange, which contain sulphur, without some risk of their becoming discolored. When used for bright colors in towns the sulphur which is usually present reacts with the lead which is in the oil, causing them to become of a brownish hue. Boiled oil which contains lead when exposed to the air gradually becomes brown. These are some disadvantages which attach to the employment of lead-boiled oil.

When manganese is used as the drier, this also forms manganese linoleate, which passes into the oil, but does not impart to it any property of becoming discolored by use in any way; it may therefore be employed with all pigments without fear of any deterioration of beauty of tint. Then, again, there is considerably more oxidation of the oil with a manganese drier than there is when litharge has been used, so that a manganese boiled oil dries much quicker than a litharge boiled oil.

*Hartley & Blenkinsop's Process.*—A new process for making a very pale boiled oil has been devised by Messrs Hartley & Blenkinsop. This consists in first treating the oil with dilute sulphuric acid; an acid containing about 30 per cent. of actual sulphuric acid is the best to use, as at this strength it dehydrates the oil, but does not carbonize it at all. After standing to allow the oil and acid to separate, the clear oil is drawn off and is ready for the next process. This consists in treating the oil with a solution of manganese linoleate in some hydrocarbon spirit. Care is taken in not adding too much of this material. It exerts a bleaching action on the oil, which becomes a very pale color, but if too much is added then further oxidation of the oil may occur, and this is not desirable. Air is blown into the oil at the same time. This materially assists in the bleaching and accelerates it considerably. By heating to about 260° F., adding just enough manganese linoleate and blowing air through the oil, the latter becomes bleached and then decomposed as in the ordinary boiling process, increases in density, acquires drying properties, while the color is quite pale. The oil so prepared is excellent for use as a paint oil, dries well and rapidly, and can be mixed with all pigments without leading to any discoloration whatever. Whites retain their purity of tone unchanged, a feature of no small advantage.

‡ *Chemical Trade Journal.*

## BLEACHING OILS.*

THE class of oils which we have in view at the present moment are the fatty oils which are obtained from animal or vegetable sources; frequently these are more or less colored, which coloration is caused by a variety of circumstances. In the case of vegetable oils, sometimes the material from which they are expressed contains a peculiar coloring matter—this is the case with cotton oil; then again there are nearly always small quantities of the peculiar vegetable coloring matter, chlorophyl, present in one or other of its forms, as is notably the case with the green olive oils. Palm oil, again, is notable on account of its containing a bright orange coloring matter to which it owes its characteristic color. In the case of animal oils, the quality of the material has some considerable influence on the color, while, further, the oil may lick up something from the apparatus or plant in which it is being treated. This discoloration of the oil has to be removed before the oil is fit for use for many purposes, although there are others for which the colored oil may be used without any treatment whatever.

Bleaching oils is a very difficult thing to do, especially on the small scale. So many and varied are the conditions which conduce to the success of the operation that very often a process which works well with one fat or oil will fail with another, and a ton of oil can be bleached by one method, and yet the same method fails with a hundredweight of the oil. As to laboratory experiments on bleaching, they are very rarely successful.

The great difficulty in bleaching oils arises from the trouble there is in making a thorough admixture of the oil with the bleaching agent which is being used, and also of exactly proportioning the amount of the latter to the oil; for if too great an excess be used, it often happens that the oil becomes colored by it to a greater extent than at first, and the remedy then becomes worse than the disease.

### THE AIR AND CHARCOAL PROCESS.

Probably the very best general process for the bleaching of oils is to take advantage of the bleaching property of a current of air combined with that of animal charcoal. To do this in the best possible manner the following process may be adopted. First of all, the oil is heated to about 100° F. and then mixed with weak sulphuric acid, made by mixing one gallon of ordinary strong sulphuric acid with two gallons of water, using four gallons of this weak acid for every 100 gallons of oil. The mixture is well stirred together, and then heated to about 180° F., when it is allowed to cool down. After cooling the acid will be found to have settled at the bottom and the oil will be freed from any animal or vegetable matter and moisture by this process, while the oil itself will be but little affected. The next proceeding is to separate the acid from the oil, which may be done in any convenient manner. A current of air is then blown through the oil by means of a pump or fan as is most convenient. The blowing should not occupy more than two hours. Next a tall cylindrical boiler placed on end is filled with dry animal charcoal, the pieces of which should not be too small. Lumps about the size of a pea are best. At the upper end of the boiler is a manhole for feeding, while at the bottom is a hole for running off the clarified oil. The oil treated as above described is now run through this boiler, the contents of which work best if heated to about 100 to 120° F. Possibly a single passage through the charcoal may not effect the desired amount of bleaching, but a repetition of the passage will assuredly do so. One advantage of this method is that the oil is not injuriously affected by the use of chemicals, and it is clarified from any solid matter it may contain in suspension. One disadvantage is that the charcoal retains a large proportion of the oil, which, however, is practically recovered in subsequent batches. The charcoal will serve to treat a large quantity of oil, and should it lose its bleaching properties, they may be restored by first extracting the oil it contains by means of benzoline or some such solvent, then heating the charcoal to redness in a closed retort.

### THE SULPHUROUS ACID PROCESS.

A very good plan of bleaching oils, which may be adopted more especially with the green olive oils, is first to treat them with weak sulphuric acid as directed above, then to blow air into them which has been passed through liquefied sulphurous acid gas for some time, until the oil has become sufficiently decolorized. It is then washed with warm water to free it from sulphurous acid, the water allowed to settle, and the clear oil used.

This process may be modified as follows: The oil is treated with weak sulphuric acid, and then, after separating the oil and acid, the former is run into a tank with from four to five gallons of liquid bisulphite of soda for every hundred gallons of oil being treated; air is then blown through the mass, the oxygen of which, along with the sulphur dioxide liberated from the bisulphite, effecting the bleaching of the oil.

The introduction of peroxide of sodium, which is chiefly made by the Aluminum Company at Oldbury, has placed a new bleaching agent at the command of the oil bleacher which will be found very serviceable in many cases. This product cannot, however, be used directly, or it would simply bring about the saponification of the oil, which is not desired. To use this product the peroxide of sodium should be mixed with about three times its weight of magnesium sulphate (Epsom salts). It must be kept in tight cases of metal or in bottles. From one to one and a half pounds of peroxide of sodium will be required per 100 lb. of oil. The mixture of peroxide and Epsom salts is mixed with water, and this is then added to the oil, the whole being warmed to about 130° F. and thoroughly agitated together for some time, then it is allowed to stand for the oil and aqueous liquor to separate, when the oil can be drawn off. As a general rule the oil will be found to be bleached sufficiently, a repetition of the process only as a rule being necessary when very dark oils are being treated.

* *Chemical Trade Journal.*

## COTTONSEED OIL RUBBER.

By C. B. WARRAND.

PRODUCTS from drying vegetable oils having been employed for many years as substitutes for rubber or caoutchouc, a description of their employment in the past will probably be of some interest to our readers, as it strongly indicates the adaptability of cottonseed oil as one of the best substitutes for rubber, if rubber obtained from same is not an artificial rubber.

If linseed oil, for instance, be brought to a thick glue-like consistency by boiling for at least twenty-four hours, and dilute nitric acid be added and the boiling be continued for several hours longer, the linseed oil will be changed to a plastic mass, which will become hard on exposure to the air. On dipping this mass in hot water it regains its softness, and on cooling it hardens again. This product is the caoutchouc or rubber of drying vegetable oil, which can be produced from any vegetable drying oil, but less economically than from linseed oil.

Nitric acid is one of the best oxidizing agents, and the production of this oil caoutchouc is evidently a result of the oxidation of the linseed oil. Just in the same way cottonseed oil can be oxidized and will form a rubber or caoutchouc, although different means have to be used for the effective oxidation of cottonseed oil, as it is not strictly a drying oil, but it is an intermediate between drying and non-drying oils.

This oil caoutchouc is of considerable commercial importance, as it forms the basis of a great number of industrial products. If linseed caoutchouc is mixed with litharge, it is excellently adapted to the manufacture of bougies, catheters, flexible sounds, and many other surgical instruments, and it has been used for this purpose for many years.

The oil caoutchouc can also be readily vulcanized by chloride of sulphur dissolved in benzine or carbon disulphide, with or without the admixture of magnesia, lime or baryta, or various lead, copper, zinc, or antimony oxides. It is also largely used in the manufacture of linoleum or oil cloth; it also makes a very good waterproof material, if a small quantity of natural rubber is added. Linseed oil consists of a mixture of linolein, the glyceride of linoleic acid; about 80 per cent. of the same consists of olein, palmitin, and myristin.

The well-known quality of linseed oil as a varnish is increased by boiling with such mineral substances as are capable of yielding a portion of their oxygen to the oil, thus causing a partial oxidation of the oil. For this purpose plumbic oxide (litharge), red lead, and anhydrous linoxide of magnesia are employed. The last two are used conjointly, and to these oxidizing agents have been added lead oxides, plumbic acetate, zinc sulphate, etc.

By boiling not only does a partial oxidation take place, but by increasing the temperature to between 600° and 700° the mucilage and other impurities of the oil are driven off as a yellow froth, or they are removed by partial destructive distillation.

The partial oxidation which occurs by thus boiling linseed oil is finished when thin coats of this varnish are exposed to the air and sunlight, forming a complete coat of oil caoutchouc; hence the unsurpassed value of linseed oil as the basis of the best known varnishes.

Cottonseed oil consists of 30 to 34 per cent. of palmitin and 66 to 70 per cent. of olein; hence it is quite probable that it can be used the same as linseed oil, as in both the predominant part is olein. That it has to be treated differently from linseed oil to obtain the same results is also likely. The palmitin commences to harden at 55° F., and is completely congealed at 32°, while the oil or olein does not congeal above 28°; hence it is an easy matter to separate the palmitin, which is, however, better known as the stearine of commerce, by simply reducing the temperature of the crude oil to 28° F., and expressing the oil in a filter press. This stearine is largely used in the manufacture of refined lard, and while a pound of crude oil is now worth about five cents, the crude stearine is worth some eight or nine cents per pound.

After separating the palmitin the oil has to be refined and bleached before it can be used for culinary purposes or for the manufacture of numberless artificial butter products, called butterine, oleomargarine, etc. This is usually accomplished by the use of carbonate or caustic alkalies and sulphuric acid. Such a treatment of the oil, however, seems to cause some change in the oil which renders it incapable of further oxidation. By long exposure to the air and sunlight this refined oil does not thicken and oxidize, but it becomes rancid and acrid; hence experiments to produce rubber from refined oil of commerce will always fail, while it is comparatively an easy matter to oxidize crude cottonseed oil deprived of its stearine.

Some five or six years ago an English inventor sold to an American rubber manufacturer for a considerable amount a secret process for manufacturing cottonseed oil into rubber. Since then this secret has become the property of the rubber trust. This process has been used ever since, and it is a matter of fact that large quantities of cottonseed oil are now being used by at least fifteen or sixteen rubber factories in the United States to produce a substitute for rubber. This is in the United States alone. I do not know to what extent this process is being used in England and on the Continent, but as it originated in England, it is probably used to some extent there also.

By this process the converted cottonseed oil costs about seven cents per pound. The admixture of this substitute has been limited to about 15 per cent., as it is not deemed advisable to exceed this amount without deteriorating the quality of the rubber product.

The specific gravity of crude cottonseed oil is 0·93; if the palmitin is removed, the gravity of the remaining oil is lowered to 0·921. By boiling the oil for some time the impurities are removed and the specific gravity is lowered a little more; but by my experiments the specific gravity increases as the oxidation of the oil proceeds. What I considered perfectly oxidized oil or finished rubber has a gravity of 0·925, which is identically the same as that of pure rubber.

There is no known way to ascertain the quantity of pure rubber employed in finished products by the way of a chemical analysis. The only known way to approximate the purity of finished rubber products is by the specific gravity of the same. Hence a substitute which has the same specific gravity, the same elasticity, the same faculty to vulcanize, is a very valuable substitute, if it is not of identically the same chemical composition.

Rubber is composed of nine atoms of carbon and seven of hydrogen. It is, however, quite probable that there is a more complex mixture of various hydrocarbons, which have, so far, not been ascertained.

The composition of olein is eighteen atoms of carbon, thirty-four atoms of hydrogen and two atoms of oxygen. This formula divided by two would give nine atoms of carbon, the same as rubber, seventeen atoms of hydrogen and one atom of oxygen. Assuming that ten atoms of hydrogen were combined with the atom of oxygen and other oxygen from some other source—from the atmospheric air, for instance, by heat, sunlight or electricity, or from some oxidizing agent like ozone—the result would be chemically pure rubber and water, which would evaporate.—*Chem. Tr. Jour.*

## PANTOMETRIC GUIDE COMPASS.

THIS compass, according to its inventor, is designed especially for army officers, but may also be usefully employed by explorers, tourists, bicyclists, etc. It differs from ordinary pocket compasses in that, by a very simple process, it gives the geographic north and the magnetic north, whatever be the declination of the place in which the observer chances to be, and consequently permits of automatically solving, by means of what is called an azimuthal protractor, all the important problems of the map with precision and with great rapidity. It may, besides, serve as a sun dial.

As shown in the figure, it consists of a box containing a graduated limb capable of revolving with hard friction around the axis of the compass through the aid of a rod that is introduced successively into apertures formed in the side of the box. It is closed by a mirror cover divided in two by a line that determines the axis of the compass, and is provided with an aperture for sighting.

The bottom of the box also is divided in two by a line that likewise determines the axis of the compass. This line and that of the mirror constitutes the plane of the sighting. A graduated dial fixed upon the left side permits giving the cover any inclination whatever. A binding screw keeps the cover in such position. The compass is completed by a false needle that revolves freely over the glass, and by a reference point placed in the axis of the compass. A copper support provided with an aperture for the passage of a copper point permits of fixing it upon any piece of wood whatever. Finally, from the side of the box hangs a chain carrying a copper rod that serves to revolve the graduated limb as well as the style of the sun dial.

The azimuthal protractor measures the angles with respect to a fixed direction—the geographical meridian. It is provided with a cross-ruled disk that is applied to the map in such a way that its lines shall be parallel respectively with the parallels and meridians. It is of sufficient size to permit the cross ruling to always cover one of these lines.

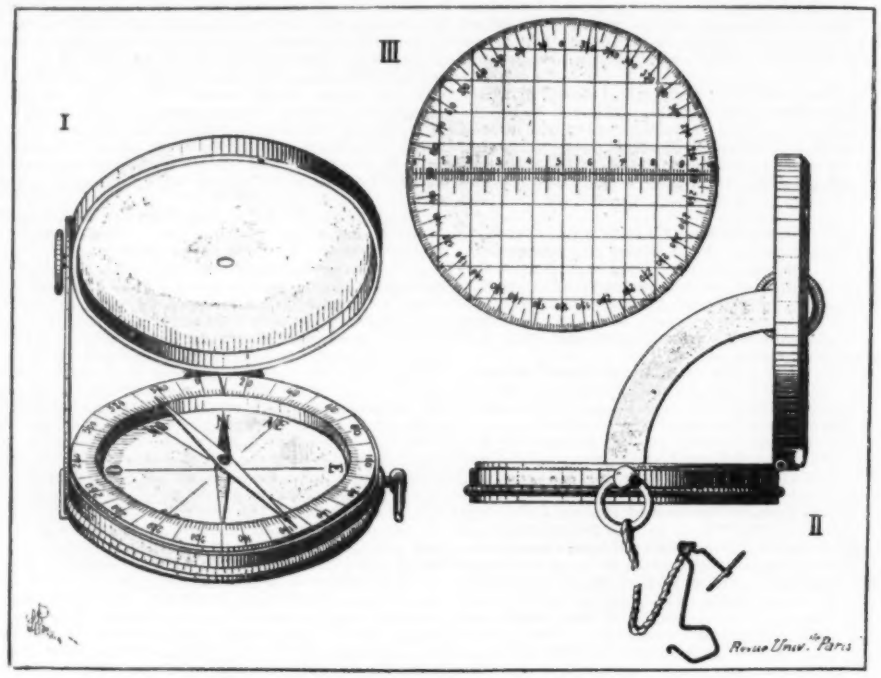



FIG. 1.—PANTOMETRIC COMPASS GUIDE.

I. Interior view of the compass. II. Elevation of the box, open. III. Azimuthal protractor.

It is graduated upon the sides in such a way that if the two faces be supposed to be turned down upon the same plane (as shown in the figure), we shall have a complete division of the circle into 360°, the north part comprising the divisions from 0° to 90° and from 270° to 360°, and the south part those from 90° to 270°. The rectilinear side of the protractor is graduated into centimeters and millimeters and serves as a rule.

Before using the compass it is necessary to decline it, this being easily done in one of the following ways: (1) by means of the map; (2) by the process of corresponding heights; and (3) by means of the pole star, of the sun, of the passage of the stars at the meridian, or of the sun and a watch.

The principal problems that the apparatus permits of solving are: (1) the exact determination upon the map of the point at which one is situated; (2) knowing such point, the exact determination of the direction of the points invisible upon the ground; (3) the tracing of the direction to be taken in order to go from the point at which one is situated to any other, visible or invisible; (4) the determination of any angle whatever with a given direction; (5) the operations of rapid surveying, planimetry, leveling, determination of distances, etc.

For all such operations it is preferable to fix the compass upon a support rather than to hold it in the hand.

FIG. 2.—INSTALLATION OF THE PANTOMETRIC COMPASS GUIDE FOR OBSERVATION.

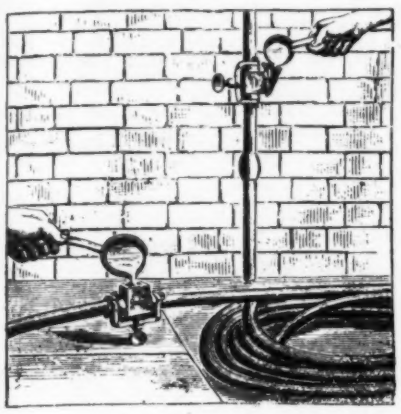
The support may consist of a simple stick of wood sufficiently rigid and firmly implanted in the earth. The compass is held in place by means of the support that we have already mentioned, and that is capable of revolving in all directions around a copper point inserted in the wood.

The mirror raised vertically, and the eye so reflected that it is divided in two by the vertical line, determine a very satisfactory sighting plane.

The sighting may also be done by placing the mirror at any inclination and putting the line of the bottom of the compass in concordance with the line of the mirror. These two lines determine the sighting plane. The object sighted should appear exactly in the center of the aperture—an operation very easy for the eye and of great precision.—*Les Inventions Nouvelles.*

## NEW PIPE JOINT.

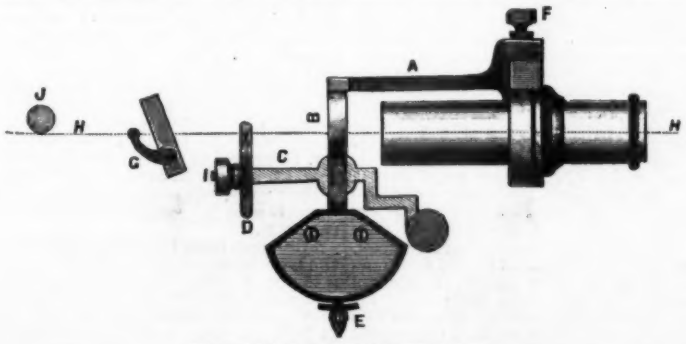
A NEW kind of joint for all kinds of plumbing, but especially chemical plumbing, has recently been introduced by the Portable Oil Furnace Company, Limited, of Nottingham, which can be made by means of their new patent tie-joint moulds. These moulds are something new to the plumbing world, as they claim to make plumbing joints with either lead or solder without obstructing the waterway, or using brass tube for the inside of the lead pipe. This has been wanting for some time, especially in the case of chemical works, as ordinary solder is practically useless in such cases. The tie-joint mould entirely does away with all old difficulties, such as weeping and sweating of joints, through the solder being porous, as lead is the material used. Every joint is guaranteed to stand a pressure of 900 pounds per square inch. The joints are made proportionate in strength to the size of the pipe.



The cost is also another noteworthy feature, as these moulds make better joints with old lead worth about one penny per pound than can be made by the old method of "wiping" with solder costing about seven pence a pound.—*Chem. Tr. Jour.*

## THE ANGLEOMETER.

THE instrument shown takes the form of a very simple attachment for the sextant or quadrant, devised by Captain James B. Murray, of Glasgow, to determine and maintain the horizontal plane of the observer's line of sight, making it now possible for navigators to obtain reliable altitudes of celestial objects at sea without a horizon of any kind, and is quite independent of the height of observer's eye above the sea level. The device consists of an attachment secured to the telescope holder by a thumb-screw, as shown below. It consists of a balanced fork with a fine wire at right angles to the plane of the sextant. This fork has a vertical slot on the lower part, and is attached to one end of a horizontal lever by means of a binding screw, capable of vertical and circular adjustment; this is counterbalanced by a small disk at the opposite terminal. This lever is fulcrumed at its center of gravity by platinoid center points working in platinoid concave sockets. A vertical box balance, containing liquid, is attached to this lever at its center of gravity, and will always hang truly vertical when free. The lever with fork and fine wire being fixed at right angles to the vertical balance will always be truly horizontal when the vertical balance is allowed to assume its natural position. A fine wire is fitted to the ends of the horizon glass frame by two adjustable arms, and is adjusted truly horizontal or at right angles to the plane of the sextant, and exactly bisecting in a horizontal plane the line of sight through the telescope. The fixed wire, above referred to, can be fitted in a special telescope instead of being placed on horizon glass frame, at shown in the above illustration. The telescope is fitted with an adjustable horizontal wire at one end, bisecting the line of sight, and having an adjustable sight at the other end for adjusting the same to suit the observer.




MURRAY'S ANGLEOMETER.

Referring to the illustration, A is the horizontal bar, B the vertical complement, C the horizontal balance, D the slotted fork with horizontal wire, E the thumbscrew for securing the device, F the binding and vertical adjustment screw, G the adjustable arms with horizontal wire, H the line of sight through the telescope, I the binding screw on horizontal balance, and J the sun's lower limb on horizontal plane.

The great importance of this useful instrument to masters who have valuable lives and property under their care cannot be overestimated. It will be found especially valuable to all masters engaged in the North Atlantic and St. Lawrence trades, when dense fogs are prevalent during the summer months, while the sun, moon, and stars are often plainly visible overhead, but hitherto practically useless to the navigator, except for azimuths. This instrument, under such circumstances, would be the means of relieving masters from doubt and anxiety, while it secures the safety of the vessel when the sea horizon is unreliable or completely obscured by fog. A little steady practice at first in the use of this instrument is all that is necessary to establish perfect confidence in the results. It is claimed for the angleometer that it has the decided advantage of being simple and efficient and perfectly reliable when properly used, easily adjusted when necessary, always ready for use, and does not interfere with observations being taken to the sea horizon, although attached to the sextant, where it can remain while that instrument is in the box. Several of these instruments have lately been subjected to a thorough practical test in vessels employed in the St. Lawrence trade, where thick, foggy weather predominates, and the results were found to be highly satisfactory, perfect confidence in the instrument being established after a little practice. The only objection found in practice was the difficulty of holding the sextant sufficiently steady under circumstances of excessive vibration, etc., but, as a result of a series of experimental trials, this difficulty has now been completely overcome by causing the vertical balance to work inside of a fixed quadrant-shaped box containing a specially prepared oil.—*The Steamship.*

## THE MANUFACTURE OF FIREWORKS IN FRANCE.*

THE decorative pieces that we shall speak of further along are provided with port fires, a species of blue lights inclosed in paper cases from 8 to 10 millimeters in diameter by 8 to 12 centimeters in length.

When a display of fireworks has been decided upon, the contractor comes to an understanding with the parties interested as to the allegorical subjects and the various decorations that it will be necessary to represent. The pieces selected are sketched and colored upon the floor of the work room. Then large frames of light laths are constructed, and, after the design has been covered with these, flexible rattan rods are nailed thereto in following all the lines indicated upon the floor by the draughtsman.

These decorations are often of very large dimensions. Care is taken to render each frame independent, in order to facilitate carriage. Each is numbered so as to permit of its being put in the place that it is to occupy in the decorative piece as a whole, when it is mounted at the spot where it is to be set off.

Into the bamboo, which has been painted the same color as the model, are inserted, at right angles with the plane of the piece, long points upon which are impaled the port fires of the desired color. These are spaced from 12 to 20 centimeters apart, according to the distance from which the piece is to be seen. After the port fires have been put in place, all the primers with which they terminate are connected with each other by means of a quick match, made of cotton yarn, that has been impregnated with a paste of priming powder and set aside to dry. Inclosed in a paper tube, this fuse burns very rapidly, and communicates fire to all the port fires of a piece almost instantaneously. The general arrangements just mentioned are shown in the figure; at the back, the lath frame; in front, in a darker shade, the bamboo that figures the *motif* (here a D); then, at right angles with the bamboo, the port fires; and, finally, the fuse that unites them all.

The mounting of the pieces often necessitates a very large framework formed of poles planted in the earth. By means of ropes and pulleys each piece is suspended therefrom vertically in its respective position, marked in advance. It often requires several days to prepare an installation of this kind.

The part of the display that is awaited by the spectators with the most impatience is the bouquet. This consists exclusively of rockets in a greater or less number, according to the importance that it is desired to give it. Their size varies in such a way that the largest form the top of the bouquet and the smallest are found at the bottom.

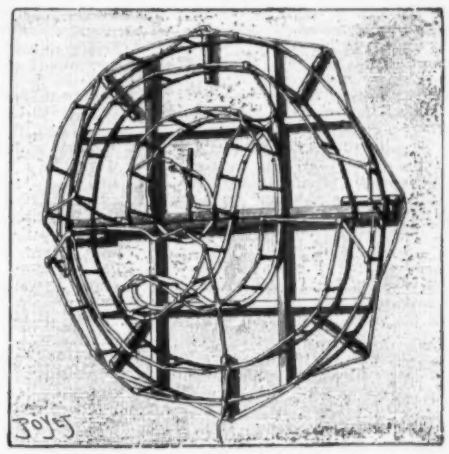
They are fixed vertically by their sticks in boxes with bottoms provided with apertures. All these boxes are connected by a quick match. The bouquet set off in the display of fireworks given in honor of the Russians at Paris, on October 23, 1893, comprised 15,000 rockets that formed a mass 30 meters in length by 6 in width. It gave a gerb that rose to a height of more than 200 meters and covered the surface of a circle of nearly 300 meters in diameter.

And now a few words as to the fire sheaves, which form the basis of all pyrotechnical pieces, such as fixed or moving cascades, mosaics, salamanders, etc. These sheaves are packed in cases like those used for rockets. The charging is likewise done mechanically, but no bore is formed as in rockets, and to the composition there are added iron or steel filings, which, in burning, give sparks of a very brilliant effect.

These sheaves serve either for revolving Catherine wheels or arms or for causing a rain of fire, mosaics, etc. Thanks to them, very varied designs are obtained.

The most remarkable pyrotechnical piece, which was created in the last century by Petronio Ruggieri, represents a salamander pursuing a butterfly, in the midst of Catherine wheels.

At the display of fireworks above mentioned, there were three large pieces: a mosaic having a frontage of 70 meters, which accompanied a large decorative piece bearing the words, "A l'Escadre Russe," in letters two meters in height; three other large pieces, called *majesteuses*, in technical language, and which consisted of wheels and palms; and, finally, two great cascades, each placed upon a parapet of the Jena bridge and falling into the Seine for a length of more than 120 meters. These were formed of 800 fire sheaves of wide caliber.



DECORATIVE PIECE FORMED OF PORT FIRES.

We shall here conclude these few notes, with the hope that they will suffice to give an idea of the genesis, so to speak, of a large display of fireworks. We trust that they will also have the practical result of making it understood how indispensable it is to take precautions at the time of installation of the pieces. At the moment that the contractor begins to erect his poles, and the pieces begin to arrive upon the grounds, the curious flock to the front in order to watch the operations of the workmen, and to examine the bombs, rockets, etc., close by. They are not satisfied to see from a distance, but wish to touch things.—*La Nature.*

## MANUFACTURE OF NITRO-GLYCERIN.*

*The General Arrangement of the Danger Area.*—A perfectly level piece of ground is unsuitable as a site for the manufacture of nitro-glycerol, as a number of buildings are required to be upon different levels, in order to allow of the flow of the liquid nitro-glycerol from one building to another through a system of conduits. The buildings inside the danger area, or that portion of the works which is devoted to the actual manufacture of explosive material, are preferably made of wood, as, in the event of an explosion, this substance offers less resistance and causes less damage than stone or brickwork. In order to confine the force of an explosion, it is also a good plan to surround all danger buildings and conduits with mounds of sand or earth, which should be covered with turf and of such a height as to be higher than the roof of the adjacent building. The conduits connecting the various buildings are generally made of wood and lined with lead, the space between the woodwork and lead lining (some four or five inches) being filled with cinders; they should also be provided with covers, which should be whitewashed in hot weather and regularly inspected. Whenever it is found that a portion of the lead lining requires repairing, before cutting away the lead it should be very carefully washed, for several feet on either side of the portion it is intended to remove, with a solution of caustic soda or potash in dilute methylated spirit; this treatment decomposes the nitro-glycerol with formation of glycerol and potassium nitrate. The mixed acids attack the lead rather quickly, forming sulphate and nitrate of lead, but chiefly the former. For this reason gutta percha pipes have been proposed, but the great drawback to their use is that in the case of anything occurring inside the pipes, such as the freezing of the nitro-glycerol in winter, it is far more difficult to find it out.

The buildings which require to be connected by conduits are, beginning with the highest, (1) the nitrating house; (2) the separating house; (3) the filter house; (4) the secondary separator; (5) the deposit of washings; and (6) the settling or precipitation house. In Great Britain these buildings require to be a specified distance apart and a license must be obtained for each. They should all be protected by a lightning conductor or covered with barbed wire, as suggested by Oliver J. Lodge. In order to keep them as cool as possible in summer, they should be made double, and the in-

* Continued from SUPPLEMENT, No. 947, page 15128.

* P. G. Sanford, *Jour. Anal. and Appl. Chem.*, 7, 1893, 224-229; and 7, 269-277.

tervening space filled with cinders; the roof should also be kept whitewashed and the windows thinly painted over with white paint.

A thermometer should be suspended in every house. It is essential that the floors of all the buildings should be washed every day before the workmen leave. If any nitro-glycerol is spilt on the floors, it should be sponged up and the place washed with an alcoholic solution of soda. The various houses should be connected with paths laid with cinders or boarded with planks, and any loose sand about the site of the works should be covered over with turf to prevent its blowing about and getting into the buildings. The works throughout should be heated by steam, brought in pipes covered with kieselguhr from a boiler house outside the danger area. A stove, entirely covered in with woodwork, should be placed in the corner of each building, and as small a length of steam pipes as possible should be within the building. Fire-extinguishing apparatus in proper working order should also be provided.

The work people inside the danger area should wear sewn leather shoes and different clothes, preferably without pockets, from those usually worn, which necessitates the erection of changing houses, one for the men and another for the girls. Brass nails or wooden pegs should be used in the construction of the buildings, and any necessary tools should be made of phosphor bronze or brass.

### NITRATION.

The acids used in the manufacture of nitro-glycerol should be as pure as possible. The sulphuric acid should have a specific gravity of 1·84 at 15° C. or contain 97 per cent. sulphuric acid. The nitric acid should be as strong as possible. Nothing with a specific gravity less than 1·52 should ever be used, and the oxides of nitrogen should not exceed 1 per cent. It should also be as free as possible from chlorine. An unsuccessful attempt has been made to free nitric acid from the oxides of nitrogen by blowing compressed air through it. E. Liebert claims that the addition of ammonium sulphate or nitrate to the mixed acids destroys the nitrous acid formed during the process of nitration, thus $(NH_4)_2SO_4 + 2HNO_3 = H_2SO_4 + 4H_2O + 2N_2$.

The best proportions in which to mix the acids are three parts by weight of nitric acid to five of sulphuric acid. After mixing, the acids should be forced up to the nitrating house in the danger area. They should be stored in a leaden chamber, large enough to hold sufficient acid for four or five nitrations, placed in a wooden house six or seven feet higher than the nitrating house. This house should also contain a smaller lead tank, holding, when filled up to a certain mark, just enough acid for one nitration.

The glycerol should be contained in a small cistern provided with a graduated gauge glass and fixed on the wall of the nitrating house. A good charge is 16 cwt. of the mixed acids and 247 lb. of glycerol. The nitration is usually conducted in a lead vessel, cased in woodwork, four feet wide at the bottom and rather less at the top. It is generally about four feet high, but should never be more than two-thirds full. The top of the tank is closed in with a dome of lead, in which is a small glass window through which the progress of the nitrating operation may be watched. A lead pipe is fitted to the top of the dome and carries the acid fumes up through the roof. The interior of the tank contains at least three concentric spirals of 1 inch lead pipe, through which water is made to flow during the *whole* operation. Another lead pipe is carried through the dome to the bottom of the tank, where it is bent round in the form of a circle and is pierced with small holes about one inch apart, through which air under a pressure of 60 lb. per square inch is forced in order to keep the liquids in a state of constant agitation. A 2 inch pipe brings the mixed acids and a narrow bore pipe the glycerol. Two thermometers are inserted into the tank, one near the bottom and the other near the top. A large earthenware tap (covered with lead) is fixed just above the bottom of the tank, so that the charge may be run down the conduit to the next house, or if necessary, in cases of decomposition, be discharged into a drowning tank. This is generally 16 feet long, 6 feet wide and 4 feet deep. It is placed close outside the building, is lined with cement and contains a large quantity of water. It should only be used as a last resource, as it is troublesome to recover the nitro-glycerol from the bottom.

After a charge of the mixed acids has been introduced, water is turned on through the coils and sufficient compressed air to stir up the acid. When the thermometers register 18° C. the glycerol is slowly admitted and the air turned on full. The nitration usually requires about half an hour, but a little extra time should always be allowed. The temperature should be kept as low as possible and should never exceed 25° C. The chief points to attend to during the nitration are: (1) The temperature of the two thermometers. (2) The color of the nitrous fumes given off. (3) The pressure of the compressed air. (4) The gauge showing the quantity of glycerol used. If the temperature rises too high, the glycerol should be turned off and the air pressure increased until no more red fumes are given off.

### SEPARATION.

When the nitration is over, the charge is sent down the conduit into the separator. This is a leaden tank somewhat similar to the nitrating vessel, but provided with a window of thick plate glass, which enables the workman to see when the separation is complete. The lead coils may be omitted from the separator, and one thermometer dipping into the nitro-glycerol is sufficient. The separator is connected by a conduit with the filter house and also with the secondary separator and the drowning tank, as the charge often gets very dangerous in this building The secondary separator is used to recover a small quantity of nitro-glycerol from the spent acids. Before the nitro-glycerol is run down to the filter house it is usually washed three or four times in a smaller lead tank, with its own bulk of water, containing about three pounds of carbonate of soda to neutralize the remaining acid. It is then drawn off into India rubber buckets, and poured down the conduit to the filter house.

### FILTERING AND WASHING.

Five or six charges are usually washed at the same time. The washing tank is half filled with water, and contains a compressed air pipe for the purpose of stirring. Four or five washings are generally necessary. The nitro-glycerol is then run into the next tank, the top of which is on a level with the bottom of the first one. Across the top of the tank is stretched a piece of flannel to remove dirt and scum. It is filtered again through another piece of flannel, and is finally drawn off into rubber buckets. At this stage it is taken to the laboratory and subjected to the government heat test (see the Explosives Act, 1875, Eissler's Modern Explosives, 267). If it does not pass this test, it must be rewashed until it does. As five or six charges are often in the filter house at one time, it is necessary to have as many tanks arranged in tiers, otherwise one or two refractory charges would stop the rest of the plant.

The chief causes of the nitro-glycerol not passing the heat test are either that the acids contained some objectionable impurity or more frequently the quality of the glycerol used. The glycerol used should conform to the following tests:

1. Minimum specific gravity at 15° C., 1·261.
2. Should nitrify well.
3. Separation should be sharp within half an hour without the separation of flocculent matter (due to fatty acids), nor should any flocculent matter be formed when the nitro glycerol is thrown into water and neutralized with carbonate of soda.
4. Should be free from lime and chlorine, and contain only traces of arsenic, sulphuric acid, etc.
5. Should not leave more than 0·25 per cent. inorganic and organic residue together when evaporated in a platinum dish without ebullition (about 160° C.) or partial decomposition.
6. Silver test should not show more than slight reaction.
7. The glycerol, when diluted one-half, should give no deposit or separation of fatty acids when nitrogen peroxide gas is passed through it.

After the nitro-glycerol has passed the heat test, it is allowed to stand for a day or two in conical tanks, in order that a small quantity of water may separate. It is then of a pale yellow color, and quite clear, and should exhibit no acid reaction.

It is *impossible* to run the waste acids away or recover them as long as nitro-glycerol is contained in it. The separation is usually effected in a tank similar to the nitrating tank. The small quantity of nitro-glycerol which is obtained is taken to the filter house, and treated with another charge. The acid may then be treated by a denitration plant of some kind. The secondary separator requires more attention than any of the other houses, on account of the danger of the decomposition of the small quantities of nitro-glycerol mixed with so much acid and water formed during the process. The composition of the mixed acids after nitration is as follows: Sp. gr., 1·7075 at 15° C.; $H_2SO_4$, 67·2 per cent.; $HNO_3$, 11·05 per cent.; and water, 21·7 per cent., with as much as 2 per cent. of nitric oxide and a little nitro-glycerol. The cause of explosions in the secondary separator is either the inattention of the workmen in charge or the bursting of one of the water pipes, the water mixing with the acids causing a sudden rise of temperature. The author also describes a nitro-glycerol plant which can be used on a smaller scale.

## LARGE COTTON MILLS.

THE largest cotton mill in the country is the plant known as the Amoskeag Mills, at Manchester, N. H. The *Textile Record* says a visit to that city would be incomplete without even viewing the impressive appearance they, together with the Stark, Amory, and Langdon mills, present as they front on the upper canal. For more than a mile this frontage stretches, in well nigh uniform height of three stories, broken only by an occasional rise at intervals into a four or five storied section. Such a view would, however, convey but the faintest idea of the immensity of the great plant of the Amoskeag Manufacturing Company, to say nothing of those of its adjoining neighbors.

To get a complete idea of this vast manufacturing enterprise, however, one must have the view from one of the upper floors of the new mill, known as No. 11, which is built on an eminence far back from the front. Mill after mill lies below, with store rooms, engine rooms and other buildings so numerous that no effort would be made to count them. The mills are built in irregular order and apparently without regard to convenience, but the internal arrangements are so well perfected, and the labor-saving devices so numerous and well applied, that even the confused appearance is not so much the result of exigencies of an ever-growing demand for greater productive power as of methods carefully planned and skillfully carried out.

On the front, the water of the upper canal washes their foundations. Behind them are other buildings extending to the lower canal, further back others yet down to the Merrimack River, and still others with latest important mill additions beyond the river itself. Three watercourses are thus included in the area covered by the mills, giving a water power of unusual abundance, utilized in the Amoskeag Mills alone for driving wheels up to 12,000 horse power. Great as this is, the mills are not by any means entirely dependent upon it, for their steam resources are equal to 8,000 horse power.

The dimensions of only a few of the buildings will serve to convey an impresssion of the gigantic proportions of the whole. The largest mill of all, No. 11, already referred to, and the most recently built, is 900 ft. long by 103 wide, and 4 to 6 stories high. The Jefferson Mill, a complete factory in itself, is 512 ft. by 101 ft., 5 stories high throughout, and No. 9 is 473 ft. by 100 ft., 4 stories high. The mills in the aggregate contain a floor space of 60 acres. The cloth storehouse is 600 ft. by 72, with 3 stories, and the cotton storehouse 1,100 ft. by 68, 3 stories high, with a storage capacity for nearly 40,000 bales of cotton; while the coal shed, when full, will hold 32,000 tons of coal.

The mills contain nearly 300,000 spindles, of which over 40,000 are mules, and between 10,000 and 11,000 looms. In two mills alone, Nos. 11 and 9, are 6,000 looms, the former taking 4,000 as its share. In it one room is 533 ft. long and 103 wide, containing 1,000 looms. Every operation in cotton manufacturing is conducted within the boundaries of the mills, even to the building of looms, spinning frames, carding machines, and other mechanical and engineering work. The presiding mechanical genius of the whole is the superintendent, Captain Manning, and his inventive powers are seen in a number of time and labor saving devices in the spinning and weave rooms. The chief of these is the contrivance, by aid of an additional pulley, whereby one belt is made to drive two looms. The saving in belting and in shafting, without loss of speed or power, is said to be something remarkable. This device has not been seen in any other mill so far, but as it appears to be pretty common knowledge that such a contrivance is in operation, there is no objection to mentioning it here

The Amoskeag has the largest wood-rimmed fly wheel in the country, 30 ft. in diameter, driven by water power, while another wooden-rimmed fly wheel, 28 ft. in diameter, is said to be the largest in the country driven by steam power. It can also claim the most remarkable boiler house in the country, with its 50-odd Manning upright boilers. A boiler house ordinarily wears an uninviting appearance, but these boilers, fully exposed to view in their whole length, cased in bright sheet iron, present a really handsome appearance.

The mills employ 8,000 hands, of which about 4,500 are females, and consume 600,000 pounds of cotton per week when running full, as they are at the present time. Their productions are the well known staple fancy and fine ginghams, denims, ticks, and other coarse yarn, colored cottons and grain bags. The A.C.A. ticks were first made known to the trade in 1826, under the original Amoskeag Cotton and Wool Factory (founded 1810). The Amoskeag Manufacturing Company dates from 1831.

The Amory Mills are three in number, containing 119,152 ring spindles and 3,000 looms. They employ 1,400 hands, and consume 175,000 pounds of cotton per week.

The Stark has six mills, with 80 000 spindles and 2,500 looms, employing 1,650 hands. The former is running on sheeting, shirting, and jeans; the latter on sheeting, shirting, drills, duck, and bags, and, with the Langdon, are working on full production.

The Manchester Mills are another important concern in this city. They contain 74,000 ring spindles in the cotton mills and 18,000 worsted spindles in the dress goods mills, with 1,152 cotton and 2,075 worsted looms and 22 combs; while in the print works there are 16 printing machines. These mills are running full time in the cotton and print departments, but turning out only about 75 per cent. of normal production in the worsted dress goods division.

## POWDER FOR CANNON.

IT is rather singular that while commendable progress has been made in the manufacture of some sorts of powder for military purposes, in brown powders for heavy guns the results have been less satisfactory. The difficulty seems to be that when a good powder has been obtained it is not reproduced. Gen. Flagler noted in his annual report that when a large number of lots of powder had been manufactured for the 12 inch rifle, and the fifth lot came up to the ballistic requirements, no subsequent lot reached even a close approximation to it until the eighteenth had been delivered. It was further noteworthy that the very lot before this last gave the enormous chamber pressure of about 76,000 pounds per square inch, with a charge of only 350 pounds, although the normal charge was 450 pounds. Somewhat similar results had occurred with powder made for the 10 inch rifle.

Turning to smokeless powders for heavy guns, it is found that tests were made during the year reported upon with the French B. N., the German, the United States navy, the English cordite, the Austrian Troisdorf, and the American Leonard.

The firings of the French B. N. with the 12 inch rifle included two in 1892 and two in 1893. The weight of the projectile was 1,000 pounds and that of the charge 304 pounds. On July 10, 1892 a firing showed 1,846 feet per second of muzzle velocity with 26,400 pounds per square inch of chamber pressure. On the following December 1 the muzzle velocity had increased to 1,957 feet per second and the chamber pressure to 28,000 pounds, the powder having been stored since August 5 in barrels. On July 25, 1893, a charge of 197 pounds thus stored, which had shrunk from 200 pounds, yielded 122 feet of muzzle velocity and 29,000 pounds of chamber pressure. But a fortnight later a 204 pound charge of powder that had been hermetically sealed since August 5, 1892, yielded 1,895 feet of muzzle velocity with only 26,600 pounds of chamber pressure, thus corresponding remarkably to the original firing of the year before. So far, therefore, as these four single rounds are a guide, this French B. N. proved very satisfactory for large caliber rifles, especially when aided by hermetical sealing. It is to be observed that there is no nitro-glycerine in it.

For more than two years there have been trials of the German smokeless powder in the 8 inch rifles, with a 45 pound charge and a 300 pound projectile. The first round, July 24, 1891, gave 2,000 feet of muzzle velocity, with 30,100 pounds pressure. A year later, July 26, 1892, two more rounds were fired, one with powder ordinarily stored in barrels and the other with hermetically sealed powder, with the result that the former yielded 1,949 feet of muzzle velocity and 29,900 pounds of pressure, while the latter gave 1,968 feet and 30,400 pounds. Eight months later, March 21, 1893, another charge of the hermetically sealed powder yielded 1,973 feet and 30,100 pounds pressure, thus showing a loss of only 27 feet in muzzle velocity and not a pound of increased pressure from the original firing twenty months before. Finally, on August 28, or a little over two years after the first firing, a charge that had been stored in metallic cases, but not sealed since September 1, 1891, yielded 1,933 feet of muzzle velocity, but with a gain to 32,400 feet of chamber pressure. On the whole, this German smokeless powder also shows up to good advantage, especially as hermetical sealing is perfectly practicable in forts, and will be made the rule in our service. And yet this powder contains nitro-glycerine. Our ordnance department hesitates to affirm or deny that this substance injures keeping qualities, and had found nothing against it up to a recent date. One marked ad-

vantage of the German powder is that the cubical form of its grain facilitates making up cartridges.

Cordite is the regular service smokeless powder in England for rapid fire guns, and it has been used experimentally for heavy ordnance. It contains nitro-glycerine, but the English government seems to have satisfactory evidence of its stability. A couple of rounds of it in a 4·7 inch quick-firing Armstrong, tried by our ordnance authorities, with a charge of 5¼ pounds and a 45 pound projectile, yielded the good muzzle velocity of 2,229 feet, with a powder pressure of 31,500 pounds.

The Troisdorf powder, which has no nitro-glycerine and is but slightly affected by heat, was tried in the 5-inch siege rifle. A round with 6 pounds 10 ounces yielded 2,049 feet of muzzle velocity and 33,200 pounds of chamber pressure; but another round with 6 pounds 12 ounces and the same 45 pound projectile, with an increase only to 2,071 feet of muzzle velocity, is said, unless there is an error in the printing, to have yielded 37,500 pounds of chamber pressure.

But the most remarkable results are those obtained with the American Leonard powder in the 5-inch Brown segmental wire gun with a 63 pound projectile. A 15 pound charge yielded 2,397 feet of muzzle velocity and 32,800 pounds of chamber pressure. A charge of 17 pounds yielded 2,521 feet, with 35,100 pounds; a charge of 21 pounds yielded 2,874 feet and 46,600 pounds. The Leonard has also made a great record for itself as a powder for military small arms. It is believed to contain nitro-glycerine, but it provides good keeping qualities, and these latter are to be tested thoroughly. Tried in 3·2 inch field guns, it showed a superiority over the French B. N., the United States navy, and the Troisdorf. It may be remarked that the sample of navy powder used did not appear well adapted to a gun of such small caliber as the 3·2 inch, since much of it was thrown out unconsumed. While experimenting with the Troisdorf powders it was found that a short cartridge of large diameter gave a much higher pressure than if made up into a cartridge of smaller diameter extending the whole length of the chamber.

One further point in this matter may be noted. While smokeless powders yield a much higher velocity, it is said that the high heat they evolve, especially those that are chemically combined, fuses and corrodes the metal at the surface of the bore, and perhaps alters the molecular condition of the steel. This would shorten the life of the gun. Still, since the advantages given by a smokeless powder are great, the remedy suggested is that of relining the gun when necessary with a thin tube. This in its turn would be a troublesome and costly operation, so that possibly a compromise may be made in demanding less remarkable ballistic results for the sake of producing less wear on the cannon.—*N. Y. Sun.*

## H. M. S. HAVOCK—TORPEDO BOAT DESTROYER.

ON Saturday, December 2, we were favored with an opportunity of enjoying a prolonged trip from Gravesend upon the above vessel, which has just been completed for her Majesty's navy by Messrs. Yarrow & Co., of Poplar. The party on board consisted of some 120 interested persons, and, as the day was remarkably fine, though frosty, a very enjoyable trip of about 100 miles was experienced. The Havock forms the first of a fleet of thirteen vessels ordered by the Admiralty from different builders, and intended for overhauling and destroying hostile torpedo boats, and to accomplish this must necessarily have a speed of from 26 to 27 knots.

The honor of having turned out the first vessel of this new type has fallen upon Messrs. Yarrow & Co. The Havock passed through all her official trials with perfect success and without the slightest hitch; the mean speed tested under the stringent conditions enforced, carrying a load of 35 tons, was rather more than 26 knots an hour during a continuous full speed run of three hours' duration. The speed stipulated for in the contract was 26 knots an hour, and all who were present at the trials were thoroughly convinced that the principal difficulty those in charge had to contend with was rather to prevent the boat running away altogether than to attain the speed stipulated. During the three hours' run there were periods when she exceeded 27 knots an hour, the engines exerting about 3,500 horse power, and this was obtained a few weeks ago out in the German Ocean in bad weather.

The Havock is 180 ft. long by 18 ft. 6 in. beam; is a single deck vessel, in form greatly resembling the first-class sea-going torpedo boats built by this firm. Forward there is a long turtle deck, well elevated above the water line, which covers in a lofty forecastle, in which the larger number of the crew are berthed. At the after end of this turtle deck is the usual conning tower with steering wheel. The next compartment is filled up with berths, and abaft a separate compartment is devoted to the cook, and contains also fresh water tanks and two more berths. From the galley to the engine room are the two boiler compartments containing each a powerful locomotive boiler with copper fire box, each boiler being capable of working up to 180 lb. per square inch, and of generating steam sufficient for the development of 1,800 horse power, to produce which requires no less than 30 cwt. of coal per hour. The engine room contains two sets of inverted triple-expansion engines capable of developing collectively without undue forcing 3,500 horse power, each set of engines driving a screw. In the same compartment are two surface condensers, two centrifugal pumps and engines for driving them, fan engines, steam bilge pump, evaporator and distiller, air-compressing engines, and engine dynamo for the search light; and, lastly, the engine for actuating the rudder, which can be controlled from either the forward or after steering station. Abaft the engine room are two cabins for the engine room artificers, then comes the officers' mess room with its pantry, and last of all, quite at the stern, a large store space.

The armament consists of an 18 in. bow torpedo tube for firing direct ahead; also, two 18 in. swivel torpedo tubes for side firing, which are placed on a turntable well aft of the center of the hull. On the forward conning tower, well elevated above the water line, is a 12 pounder quick-firing gun, which practically has an all-round range. There are also two 6 pounder quick-firing guns, one at each side, and finally, a 6 pounder placed on a high stand near the stern, which, owing to its position, has a very extensive range of fire. The depth of the boat being so much greater than is necessary for head room, admits of a water-tight flat or lower deck: this has been built in the boat just above the water line, extending from the stem to the forward stoke hold, which adds greatly to the safety of the craft in case of collision, and below under the floors of the cabins are spaces for magazines and stores. The coal carrying capacity of the Havock is 60 tons, and the supply is placed in bunkers along each side of the boiler compartments, and is estimated to be sufficient for a run of 3,500 miles at a 10 knot speed. The complement of officers and men to man this vessel is 42, for whom there is sufficient accommodation, but they must expect to be rather closely packed.

The propellers are three bladed, and the engines have cylinders 18 in., 26 in., and 39½ in. diameter, by 18 in. stroke. A piston valve is provided to each cylinder, and vertical vibrations are prevented by "bob weights," as described by Mr. Yarrow in his paper before the Institution of Naval Architects. The steering capabilities of the Havock are good, her minimum turning circle being, it is stated, 200 ft.—*Industries.*

## WILLIAM SHOTTON.

YET another addition to the list of heroic Englishmen, though this time it is a lad of only eighteen years of age, William Shotton, of Sunderland. The ship Trafalgar, a big, four masted bark, of which Shotton was an apprentice, put off from Batavia for Melbourne. Fever broke out among the crew, and one after another the captain and all the mates died or were too ill to move. The command fell on the young shoulders of Shotton. With the captain dead, the chief mate a raving lunatic, and half the crew sick, this youth, at the age when many English boys are thinking of nothing but football and cricket, took command of the fever-stricken vessel, and with no officer to help him, navigated her through a stormy voyage of several weeks, till at last Melbourne was safely made. A splendid piece of work, and while we have such youngsters as Mr. Shotton in our merchant service we need have no fear of our losing command of the seas.—*St. James's Budget.*

WILLIAM SHOTTON, THE BOY CAPTAIN.

## JOSEPH WILSON SWAN.

To Joseph Wilson Swan belongs the honor of having invented the carbon incandescent lamp, as well as of having perfected the process of its manufacture, although he unfortunately delayed in applying for a patent, and was thus, for legal purposes, forestalled by Mr. Edison.

Pirating a phrase of Wendell Holmes, Mr. Swan says he is sixty-five years young! To be exact, Joseph Wilson Swan's birthday was October 31, 1828. He is a native of Sunderland, was educated there, and lived there until his eighteenth year, when he removed to Newcastle-upon-Tyne. At Newcastle Mr. Swan spent the next thirty-five years of his life—chiefly in commercial pursuits. These were, for the most part, connected with chemistry, and did not prevent, but rather helped, Mr. Swan to keep in touch with progress in scientific discovery. It was during this time that he carried out the experimental work which culminated in the invention of his electric lamp. For the last twelve years he has resided at Bromley, Kent, where he has devoted himself entirely to research—chiefly in relation to electro-chemistry. Some of the results of this work were brought out at the lecture delivered by Mr. Swan at the Royal Institution last year.

Mr. Swan is what is popularly known as a self-made man, that is to say, he does not owe a very large debt of obligation to educational training. The days of his youth were not the days of physical science colleges. What scientific knowledge Mr. Swan acquired in early life, he acquired in spite of great difficulties and discouragements. Mr. Swan is a born inventor. The bias of his mind is essentially scientific and artistic, and his inventions, which are many, lie in these domains.

His name is known most widely in connection with the incandescent electric lamp. The first lamp ever publicly exhibited, having the typical features of the lamp which has done more than anything else to popularize electric lighting, was exhibited by Mr. Swan in 1879. Another of Mr. Swan's inventions (the carbon process) has made his name a household word among photographers all over the world, but the public do not so generally know that it is to Mr. Swan we owe this most excellent of all the permanent photographic processes for the facsimile reproduction of works of art. This was the outcome of the work and ideas of thirty years ago, when Mr. Swan was greatly interested in the manufacture of collodion, a manufacture which he brought to a high state of perfection by means of an original method of making pyroxyline, which has never been published.

The world of art also owes to Mr. Swan, conjointly with Mr. Woodbury, the discovery of a new principle in mechanical printing, on which is based the process known as Woodburytype. In applying photography to ordinary mechanical modes of printing, Mr. Swan was one of the first, if not *the* first, to recognize the necessity for changing the uniform character of the gradation of light and shade in a photograph to gradation of a different character adapted to the usual methods of mechanical printing. In a more or less modified and improved form, Mr. Swan's devices to this end—patented many years ago—are still employed, and their results are seen in the wonderful photogravure reproductions of pictures, which have done so much to familiarize the public with good works of art, and in the photographic block illustrations which are so frequently seen in periodical literature. The great revolution in the art of photography, which has made every other man, woman, and child a photographer, originated in the discovery by Mr. Swan of the now universally known means of so greatly accelerating, by the action of heat, the sensitiveness of bromide of silver diffused through gelatine. Mr. Swan may justly be said to have created the modern "dry plate," though he did not publish his discovery except through the medium of a new manufacture, the secret of which very quickly spread in every direction.

Among the multitude of inventors associated with the improvement of the Plante-Faure secondary battery, it is apt to be forgotten that Mr. Swan was the originator of the cellular form of accumulator plate, and that it was he who first produced a miners' electric safety lamp, by a combination of his two inventions of the incandescent lamp and an improved secondary cell. We have not space to enter fully into descriptions of all Mr. Swan's inventions, but we cannot omit to mention his motor electric meter, which was one of the earliest of this type, nor his electric fire-damp detector.

Mr. Swan's latest achievement is the production of gold leaf by electro-deposition, and *apropos* of this, he has been heard to remark, with a twinkle in his eye, that it was the only form of gold that had ever stuck to his fingers. The late President of the French Republic and the University of Durham were among the foremost to publicly recognize the merits of Mr. Swan's invention of the incandescent lamp, the former creating him chevalier of the Legion of Honor and the latter conferring on him the degree of M.A. *honoris causa.*

A man of varied tastes and accomplishments, in literary matters Mr. Swan is critical and fastidious, and is a passionate lover of poetry. He has Tennyson by heart in every sense; nearly all the master wrote is as much in his mind as in his library. The anniversary of Mr. Swan's birthday has just passed, and we heartily wish him many happy returns.—*The Electrician, London.*

## ELECTRIC HAULING AT THE MINES OF THE BROCK COAL COMPANY, PENN.

THE mines of the Brock Coal Company consist of five drift openings in a hillside about half a mile southeast of the town of Brockwayville, Jefferson County, Pa. But four of these drifts are in operation, viz., Nos. 1, 3, 4 and 5. The seam of coal worked averages 31 in. thick. In some places it is as much as 42 in. thick, and at others it is pinched out entirely. The present production of the four drifts ranges from 300 to 400 tons per day. The inclination of the seam is very slight, being merely enough to insure natural drainage for about 5 in. in 100 ft. This dip is very regular. The seam has a hard sandstone top and a soft fireclay bottom. The coal produced is delivered at two different points. That for shipment is delivered to chutes on the Brock Coal Company's branch railroad, and from them loaded into railroad cars. The balance goes to chutes on the Ridgway & Clearfield branch of the Philadelphia & Erie Railroad, and is taken from them by the railroad company for locomotive use.

The outside tramway connecting the four drifts with the two sets of chutes is about one mile in length. It runs along the hillside and is constructed of 25 lb. T-rail. The gauge of the track is 30 in. There are grades on this line of 4·67 per cent. for 250 ft.; 3·63 per cent. for 672 ft.; 2·37 per cent. for 758 ft.; and 1·61 per cent. for 715 ft., all of these being in favor of the load. The inside grades are very regular and are about 5 in. in 100 ft. in favor of the load. There are no very sharp curves. The feeder is insulated copper wire of No. 00 B. & S. gauge, and the trolley wire is a bare copper wire of No. 0 B. & S. gauge. The feeder wire runs from the power house across the tracks to a point on the hillside above the tracks, and thence to No. 5 drift. The trolley wire runs along the upper side and close to the track. It was desirable to have a substantial, economical and convenient system of haulage suitable for a track laid with light rails running in headings or gangways where mule haulage was impossible unless excessively large quantities of the fireclay bottom were taken up. Electric haulage was deemed the best for the existing conditions, and the contract for the two locomotives and the entire plant was given the General Electric Company. The plant is such as will commend it to any practical visitor.

Two locomotives are used, each of the same type and capacity. These locomotives, designed and built by the General Electric Company, are known as T. M. M., with a capacity of 1,500 lb. drawbar pull each. They are each 32 in. high, 48 in. wide and 9 ft. 6 in. long. The wheels are 30 in., and the axles 3⅝ in in diameter. The wheel base, which is rigid, is 42 in. Each locomotive weighs about 9,500 lb., and has two motors of the new ironclad street railway type, equipped with four-pole Gramme toothed-ring armatures. The armatures are series connected so as to use only two brushes each, and these are on the upper side of the commutator, and in an easily accessible position. The armatures are connected with the axles by machine-cut single reduction gears running in gear cases filled with oil. The

frames are of cast steel and of such shape as to thoroughly protect the spools and armatures, which are thoroughly waterproofed. The trolley arms are supplied with universal joints, so that they accommodate themselves to any position required by the location of the trolley wire. Power is furnished the locomotives from a Thomson Houston D 40-220 volt generator run by an old style McEwen engine of about 80 horse power.

The rails used inside are 20 lb. T-rails, and the trolley wire is suspended from the roof, though in most instances it is over the ditch instead of being on the high side, as it is at the point where the section was taken. The "ear" or insulated hanger is used for suspending the trolley wire in position. It differs from the hanger used in earlier plants constructed by the General Electric Company, in that the wire is fastened to it by screws instead of by soldering, thus making changes and repairs easier and less expensive. These hangers are fastened to the roof by first drilling two holes into the top. Ordinary bolts with hexagonal heads are placed in the holes with the screw end down. They are wedged tightly in place by two semicircular wedges, one of which is inserted with the thick end up. The other is then driven up on the opposite side, point up. This fastens the bolts securely in place with the screw ends projecting. Then a piece of 4 × 3 in. timber, with holes bored through it just large enough to accommodate the bolts, is placed against the top. Nuts are then screwed tightly on the ends of the bolts that extend through the block, and the hanger is screwed into the wood.

In practice the locomotives have entirely replaced the mules. Each locomotive leaves the chutes with its train of 26 empty cars and when the live workings are reached drops them at the various working places. It then returns, picking up loaded cars one by one, and at some points two at a time, and returns with them to the chutes every 40 minutes. The 26 loaded cars will average 20 tons of coal. Dynamometer tests made on one of the locomotives showed a steady drawbar pull of 2,700 lb., or nearly 100 per cent. overload. The locomotive is very compact, and it is low enough to run in much smaller headings than those at the Brock mine. It is conveniently arranged, so that the motorman can control it perfectly without leaving his seat. On the surface the trolley wire is suspended at a uniform height and distance from the rail. This is also the case in the mine, as far as possible, but it is not always practicable, and the special trolley arm is therefore required. The crew employed with each locomotive consists of a motorman at $2 per day and a boy spragger at $1.25 per day.

A statement from the company gives the average cost of producing coal for eight months before the introduction of the electric plant at 83 678 cents per ton on an output of 43,454 tons. In March and April, 1893, with the electric plant the cost was 74·576 cents per ton on an output of 15,415 tons. The cost of hauling is not given separately.—*Eng. and Min. Jour.*

## THE RUSTING OF IRON AND STEEL.

"THE phenomena of chemical combination," says *Engineering*, "appear to be exceedingly complex. Not so very many years ago we were taught that a mixture of oxygen and hydrogen would combine to form water when an electric spark was passed through them. The matter appeared simple, was easily expressed in chemical formulæ and illustrated by experiment. Now we have learned that it is impossible to make such a mixture explode when it consists of perfectly pure and dry gases. When, however, the slightest trace of moisture is present, the combination takes place at once, thus illustrating the importance of those 'next-to-nothings' which were so ably and so pleasantly discussed by Sir Frederick Bramwell in his address to the British Association.

"The oxidation of iron, though a more familiar phenomenon, is at least as complex as that of hydrogen. In spite of the proverb, this familiarity has been very far from breeding contempt, as its commercial importance has attracted very considerable attention to the subject, and though there is still much to be learned, some few facts appear to be now established. In the first place, neither bright iron nor steel will rust in pure water or in pure air. The presence of carbonic acid, or some similar agent, seems necessary, although the final product may be destitute of carbon. Even when oxygen, moisture and carbonic acid are all present, rusting will not, it appears, take place unless the moisture condenses on the surface of the metal. When rusting does take place under ordinary circumstances, the first stage appears to be the formation of ferrous carbonate. This carbonate is then dissolved in carbonic acid water to form ferrous bicarbonate, which latter is then decomposed in presence of air and moisture to form hydrated ferric oxide, magnetic oxide being formed as an intermediate product. This fact as to the formation of the magnetic oxide is curious, as the Bower-Barff process of protecting iron and steel consists in coating the metal with a firmly adherent layer of this very oxide.

"Every one knows that when a bar of iron has commenced to rust the corrosion proceeds apace. A polished bar will resist oxidation for a comparatively long time, even under somewhat unfavorable conditions, but once the rust has commenced to form, it does not take long for it to cover the whole of the bar. One reason for this may be the fact that the rust is electro-positive to the iron, but it is also partly attributable to the final product, the hydrated ferric oxide, being only formed at the end of several intermediate stages of the oxidation and to its hygroscopic properties, which favor the absorption of moisture from the air. In certain situations, other acids besides carbonic may take part in the corrosion of iron. The metal work in bridges over railways is particularly exposed to fumes, and some engineers consider that in such cases no plates less than ⅜ in. thick should be made use of, even in the case of the flooring.

"The whole question of the rusting of iron and steel work has been discussed in considerable detail by Mr. Thomas Turner, Assoc. R.S.M., F.I.C., in a paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers. It is now pretty generally acknowledged that, so far as ordinary exposure to the weather is concerned, iron is less liable to rust than steel. Unfortunately, however, this capacity for resisting rust seems to be greater in the common irons than in the best qualities, and has been attributed to the phosphorus contained in the former, which seems to have a protective action.

"When iron and steel are used in conjunction, there is no certainty which will be the more liable to rust. The potential difference of contact between the two is very small, and though in general wrought iron is found to be electro-positive to steel, there seem reasons for believing that this may not be so in all conditions.

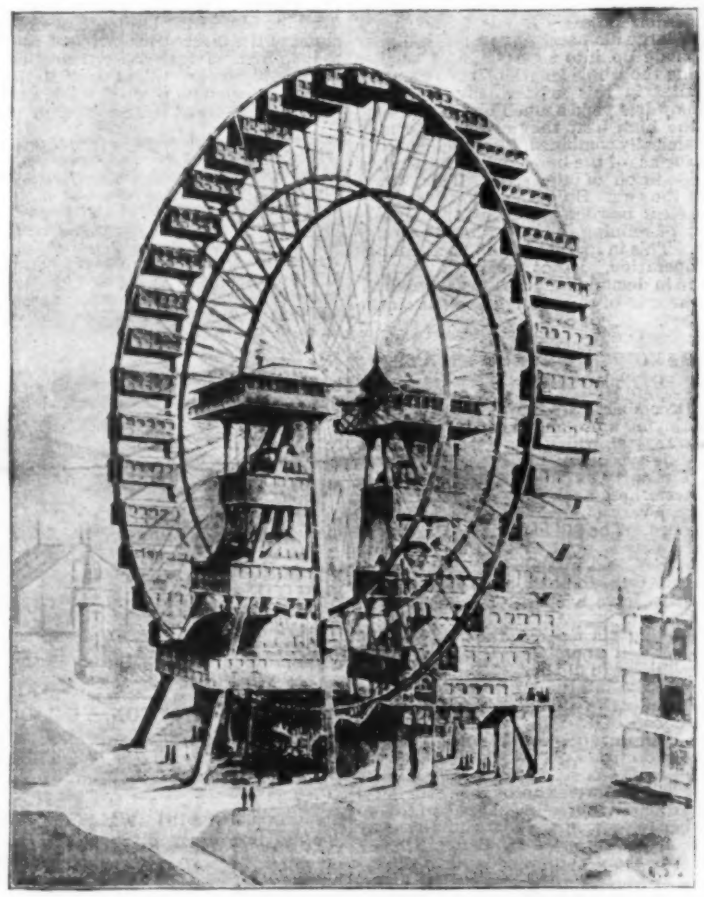
"Mr. W. Denny has instanced a case in which the steel shell plates of a vessel remained clean, while the iron stem plate and rudder forgings were much corroded. The ballast tanks of ships are particularly exposed to rust. Bilge water is an exceptionally powerful corroding agent, and several engineers have suggested the use of iron plating in ships in those parts exposed to bilge water, even when the body of the ship is of steel. In steam boilers it is claimed that there is little difference in the behavior of the two metals, and certainly steel boilers, when properly looked after, have been proved to have a long life. Plates thoroughly cleaned from scale are less liable to corrosion than when used just as they come from the rolls; and the Admiralty have accordingly adopted the practice of pickling the plates before being used. In a case of pitting, Mr. John found a particle of black oxide at the bottom of each pit. Experiment shows that this black oxide is strongly electro-positive to the plates.

"Cast iron seems in general to last better in sea water than either wrought iron or steel. Trautwine, however, relates that the cast iron cannons of the Royal George and the Royal Edgar, after an immersion of 62 and 133 years respectively, had become quite soft and were in some cases like plumbago. A very similar experience was noted with the cast iron sluice gates of the Caledonian Canal. Much apparently depends on the quality of the iron. Trautwine recommends white close-grained cast iron, while Mr. Turner quotes from a British Association report recommending gray iron.

"The alloys of iron with nickel, cobalt and chromium appear less liable to rust than ordinary iron, while the presence of manganese appears to render the iron more sensitive to attack by corrosion."

## AN ENGLISH FERRIS WHEEL.

VISITORS to the next exhibition at Earl's Court, London, will, in all probability, says the *St. James's Budget*, see what will prove to be a rival to the Watkin tower—namely, an enormous wheel and recreation towers, something after the style of the Ferris Wheel, at Chicago. The wheel, which has been designed and is being constructed by Mr. Walter Basset, of Messrs. Maudslay, Sons & Field, Limited, is to be 300 feet high, and will have suspended on its periphery 40 carriages, so hung on steel spindles that the floors will always be level. Each carriage will have glass sashes all round, with railings outside to prevent its occupants falling out. It is to be constructed entirely of steel and will be on the tension principle—*i. e.*, the weight of the periphery will always be carried by the lower half of the spokes, which will be in tension. The axle of the wheel will be formed of a tube 7 feet in diameter and 50 feet long and will be supported on 8 steel columns about 160 feet high, which will be firmly fixed on large blocks of concrete embedded in the ground, each block being 15 cubic feet. Four columns will be placed on each side of the wheel, supporting four stories, intended for refreshment rooms, the two top floors being connected by means of the tubular axle. Each of these towers will contain a searchlight, and the whole of the wheel and the towers will be illuminated with incandescent lamps. Four hydraulic lifts will give access to the various floors of the towers, in addition to two staircases. The wheel, when stopped in its proper position, will have 8 of the carriages opposite their landing stages, and thus the wheel will stop 5 times during one revolution, and during these 5 stops can fill its carriages with passengers and raise them to the height of its upper rim. The motive power will be two 50 horse power electric motors, geared by means of a worm wheel to a large drum, round which will travel two 6 inch wire hawsers, which will pass over grooves on the edge of the wheel. When filled the wheel will accommodate 1,600 persons, while the towers will hold as many more. The offices of the company are at 9 Bridge Street, Westminster.



THE NEW "FERRIS WHEEL" FOR EARL'S COURT.

## WIND PRESSURE.

PROF. KERNOT, at a meeting of the Australian Association for the Advancement of Science, submitted a paper on "Wind Pressure," which has attracted considerable attention in the engineering world. The professor, who occupies the chair of engineering in the Melbourne University, noted the inconsistencies appearing in engineering and architectural practice, with regard to wind bracing of chimneys, roofs, bridges, etc., and to the great variation in the anemometric results given by the meteorological observatories; some observatories, such as Bidstone, near Liverpool, England, and Sydney, recording pressures, or velocities corresponding to pressures, of 90 pounds or 100 pounds per square foot, while others, such as Greenwich and Edinburgh, Melbourne and Adelaide, give results only one third as great; and it was pointed out that these latter results correspond fairly well with the usual experience with railway carriages and chimneys, great numbers of which would overturn with pressures of not more than 30 pounds per square foot, and yet as a matter of fact do not overturn, and are regarded by the public as perfectly safe. Reference was next made to the experiments tried by Sir B. Baker at the Forth bridge, which showed that the average pressure on surfaces as large as railway carriages, houses, or bridges never exceeded two thirds of that upon small surfaces of 1 or 2 square feet, such as have been used at observatories, and also that an inertia effect which is frequently overlooked may cause some forms of anemometer to give false results enormously exceeding the correct indication.

The very elaborate experiments of Mr. O. T. Crosby, detailed in *Engineering* of June 13, 1890, were next dealt with. These experiments showed that the pressure varied directly as the velocity, whereas all the early investigators, from the time of Smeaton onward, made it vary as the square of the velocity. Experiments made by the author of the paper, at speeds varying from 2 to 15 miles per hour, were described, which agreed with the earlier authorities, and tended to negative Crosby's results. It was pointed out, however, that tests on a greatly extended range of velocities were needed.

The paper next described an apparatus devised by the author for determining the relative pressure of the wind on flat plates, cubes, cylinders, spheres, and other geometrical forms. This apparatus consists of a screw propeller similar to that used on steamers, 28 inches diameter and 48 inches pitch, on a 30 inch tube. This propeller is caused to revolve at speeds varying from 400 to 800 revolutions per minute by means of a gas engine. The helical currents of air proceeding from the propeller are gathered up and discharged in one approximately steady jet of 12 × 10 inch section, by

means of a radial diaphragm and a conical mouthpiece, having its axis tangential to the helical direction of the air. In front of this jet was placed the object to be tested, supported upon a very delicately made carriage, running on an accurately leveled surface plate, the force exerted being measured by a delicate spring balance, the accuracy of w. ich has been verified by means of standard weights. A large number of experiments were made with this apparatus, and many interesting and valuable facts elucidated. The ratio existing between the normal pressure on a sloping surface, such as a roof, and that upon a vertical plane was found to agree with the table given in Stoney on "Stresses," p. 334; but it was found that this result applied only to roofs supported on thin columns, under which the wind could blow freely. When the roof was placed upon a wall, as in an ordinary building, the wall deflected the current of air upward, and greatly reduced the pressure on the roof. If the wall was provided with a parapet of ordinary proportions, this effect was still more marked, the pressure being reduced to one third of what it would otherwise have been. In the case of a roof of 30 degrees pitch the pressure was actually reversed, the roof having a slight tendency to lift. In these experiments the parapet was made only one sixth the height of the roof, measured from the level of the eaves to the ridge.

Experiments were also made as to the effect of a wind blowing in at the open end of a building having the sides and other end completely closed, and it was found that the internal pressure tending to lift the roof was equal to the pressure of the wind on a flat vertical surface. The pressure upon one side of a cube, or of a block proportioned like an ordinary carriage, was found to be 0·9 of that upon a thin plate of the same area. The same result was obtained for a square tower. If the cube or tower were placed so that the wind blew in the direction of a diagonal, the total pressure was just the same as when one side was presented.

A square pyramid whose height was three times its base, and which represented a common form of church spire, experienced 0·8 of the pressure upon a thin plate equal to one of its sides, but if an angle was turned to the wind, the pressure was increased by fully 20 per cent., a curious contrast to the action on a cube or square tower.

A bridge consisting of two plate girders connected by a deck at the top was found to experience 0·9 of the pressure on a thin plate equal in size to one girder, when the distance between the girders was equal to their depth, and this was increased by one-fifth when the distance between the girders was double the depth.

A lattice work in which the area of the openings was 55 per cent. of the whole area experienced a pressure of 80 per cent. of that upon a plate of the same area. The pressure upon cylinders and cones was proved to be equal to half that upon the diametral planes, and that upon an octagonal prism to be 20 per cent. greater than upon the circumscribing cylinder. A sphere was subject to a pressure of 0·36 of that upon a thin circular plate of equal diameter. A hemispherical cup gave the same result as the sphere; when its convexity was turned to the wind, the pressure was 1·15 of that on a flat plate of equal diameter.

When a plane surface parallel to the direction of the wind was brought nearly into contact with a cylinder or sphere, the pressure on the latter bodies was augmented by about 20 per cent., owing to the lateral escape of the air being checked. Thus it is possible for the security of a tower or chimney to be impaired by the erection of a building nearly touching it on one side.

A number of interesting experiments were made upon the shelter which one surface affords to another. This shelter was found to extend in front to a distance about equal to the breadth of the sheltering surface, and behind to several times that distance. For example, a 9-inch disk being used as the sheltering surface, and a 6-inch disk being placed 2 inches in front of it, the latter received only two-thirds of the pressure it endured if the larger disk were removed, and this reduction in pressure was perceptible, though to a less extent, at all distances up to 9 inches. Behind flat surfaces eddies were found to exist, which caused other surfaces placed behind to be urged forward with considerable force. For example, a 7-inch disk placed behind a 6-inch disk, and 4 inches from it, was urged forward with one-fifth of the pressure with which it was urged backward when the 9-inch disk was removed.

In conclusion, it was recommended that 20 pounds per square foot be taken as the maximum wind pressure upon areas of not less than 300 square feet, and 30 pounds for smaller areas in positions of full exposure in the southern and southeastern parts of Australia; that in more or less sheltered positions these values might be reduced according to judgment, the minimum for extremely sheltered positions being taken as one-half the above figures; that the pressure on chimneys, towers, spires, roofs and other objects be deduced from those on thin plates of equal area by means of the results previously given; and that a factor of safety of 2 for cases of simple stability and 3 where the question is one of strength should be employed.

## VISCOSIMETRY.

PROF. PERRY has recently made some experiments on liquid friction with the apparatus shown in Figs. 1 and 2. A piece of apparatus of this nature was designed and partly constructed in Japan in 1876; that actually used was constructed at the Finsbury Technical College in 1882, but the observations only date from 1891. The simplest hydrodynamical condition of a viscous fluid is that of a fluid bounded by two infinite parallel planes, the fluid at one boundary being at rest, the velocity at the other boundary being constant and in the plane. Motions in a pipe and near a vibrating disk, or even near a steadily rotating disk, are rather complicated. The apparatus used by Prof. Perry was designed to approach as nearly as possible to the conditions subsisting between two infinite planes. Instead of planes, concentric cylindric surfaces of as large radii and as small difference in radii as could be conveniently constructed were used. E E (Figs. 1 and 2) is a cylindric trough, of which the curved parts, E, are brass.

The inner and outer radii of this trough were 10·39 and 12·65 cm.; C, which formed the bottom, was of iron, and the whole trough could be rotated about its vertical axis at any desired speed by driving the pulley, P, from a coned pulley, D, with numerous steps. G is a hollow brass cylinder supported by a steel wire, L, of 0·037 cm. diameter, 67·78 cm. long, whose axis coincides with the axis of the trough and the axis of rotation. G may be raised or lowered relatively to the trough. The outer radius of G is 11·63 cm., the inner being 11·41 cm. The whole apparatus was supported on a stand with three adjustable feet. The trough contained the liquid whose viscosity was to be determined when it rotates; G tends to rotate, and when for any constant speed G is in equilibrium, the twist in the steel wire measures the torque due to the tractive forces with which the liquid acts upon G at its inner and outer surfaces. The twist was measured by the angular motion of a pointer clamped on the wire at a distance of 59 cm. from the fixed end.

Two methods of determining the torsional constant of the wire were employed. In the first method a fine cotton thread was wound round the outside of the suspended cylinder and passed over a nearly frictionless pulley to a scale pan. The thread was nearly horizontal as it left the cylinder. In this way it was found that the twisting moment required to produce a point rotation of one degree was 1,531 dyne-centimeters. The effects due to solid friction were eliminated by taking the mean of the limiting weights for equilibrium. When the weight was 30 grammes, one-tenth of a gramme either added to or taken from the scale pan produced a perceptible change in the position of the pointer; so that the solid friction was small. In the second method the suspended cylinder was allowed to vibrate, twisting and untwisting the wire; and its times of oscillation were noted. The observations were repeated when a known moment of inertia had been added. Unloaded, it made forty complete oscillations in 583 seconds, or one oscillation in 14·575 seconds. An iron bar of rectangular section, whose own moment of inertia had been determined accurately by previous experiments, was then attached to the cylinder, this moment of inertia being 566·2, in gramme-centimeter units.

The time of a complete oscillation was found to be 21·425 seconds. From this the moment of inertia of the suspended cylinder was found to be 487·72, and the torsional constant of the wire could be obtained. From this followed that to produce a rotation of the pointer of one degree requires a torque of 1,552 dyne-centimeters. The mean value of the diameter of the wire was 0·0371 in.

Many observations have been made with this apparatus during the last year on various liquids, under very different conditions of temperature and speed and depth. In all cases the bottom of the trough was 0·5 cm. below the edge of the suspended cylinder. Keeping the oil to be tested at a constant temperature, the trough was run at a number of speeds. When a temperature had to be taken the rotation was stopped and a thermometer dipped about half way down in the oil, the reading being taken at the end of about half a minute. A small Bunsen flame was applied underneath the trough when a temperature higher than that of the room had to be maintained for a considerable time.

Sperm oil was the liquid upon which the majority of the experiments were made. The curves for this material have not been published, nor has Prof. Perry thought it worth while to make public the observations which were made upon other liquids, as errors of one degree in observing temperature were quite possible, as were also errors of half a degree in taking the deflection of the pointer. Small fluctuations in speed were continually taking place, so that the pointer was never quite still, and the motion of the fluid was therefore not truly steady.

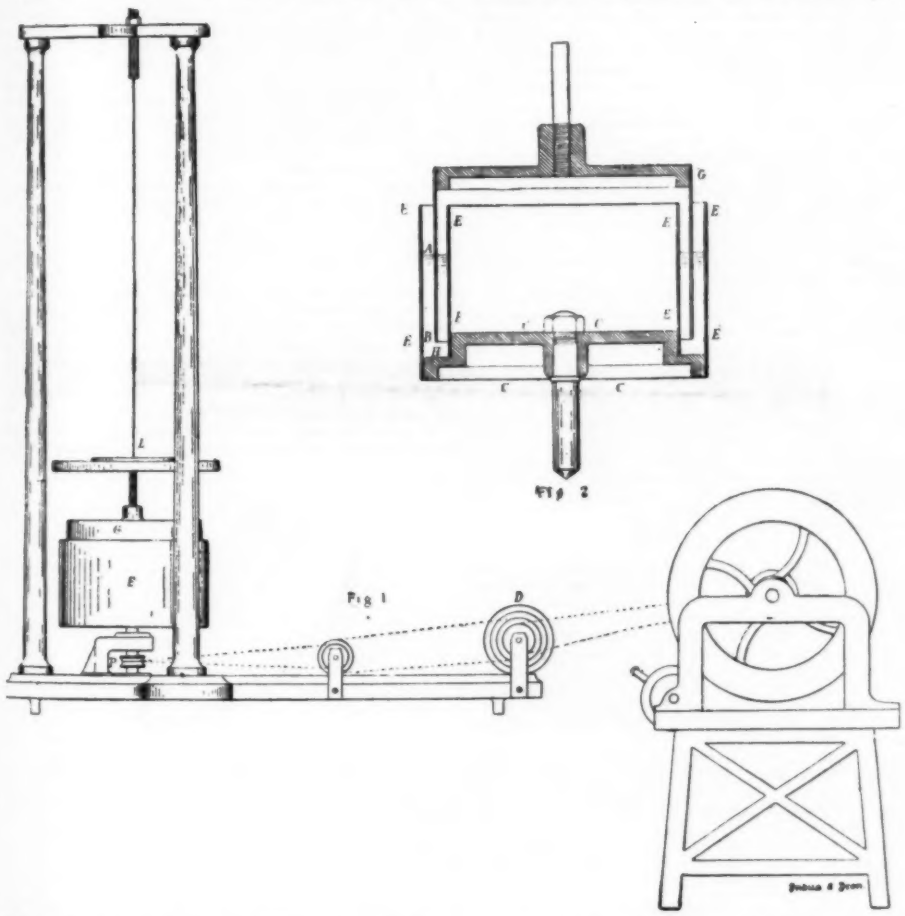



FIG. 1.—VIEW OF APPARATUS MOUNTED FOR USE.




FIG. 2.—SECTION OF CONCENTRIC CHAMBER.

FIG. 3

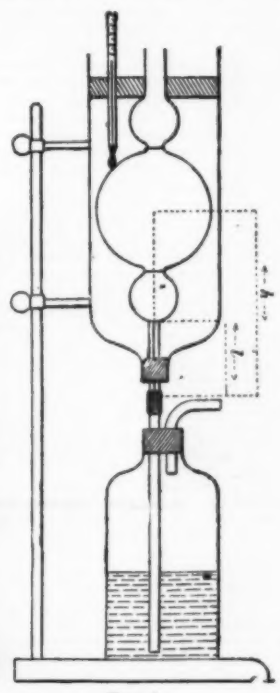


FIG 4

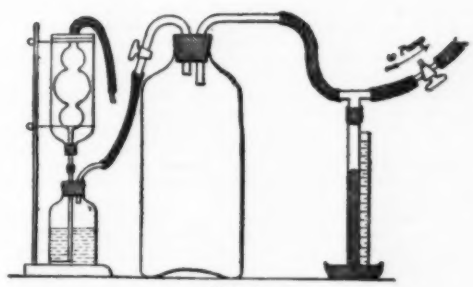


FIG. 5.

## EXPERIMENTS ON VISCOSIMETRY.

The results obtained with sperm oil have been presented in a memoir laid before the Physical Society, but they have not yet been put into a form which would be of service to engineers. Such trials will be repeated with improved apparatus much more carefully constructed, and a series of liquids will be tested, when we may expect the results to be of some practical importance. In testing sperm oil a discontinuity of some kind due to rise of temperature was found in the value of the viscosity adduced from the experiments. This has been confirmed by measurements of the specific gravity of that oil at different temperatures. The following table gives the results obtained:

| Temperature Cent. | Specific gravity. |
|---|---|
| 25° | 0·831 |
| 30° | 0·8306 |
| 35° | 0·828 |
| 40° | 0·826 |
| 45° | 0·8758 |
| 50° | 0·8753 |
| 55° | 0·8717 |

Tests of sperm oil with an apparatus which gave, not the absolute value of the specific gravity, but the relative rate of change of specific gravity with change of temperature, exhibited no sign of discontinuity, but this is not sufficient reason to doubt the accuracy of the values given in the above table.

*A New Torsion Viscosimeter.*—The viscosity of oils is usually determined by viscosimeters, which are based on the principle of allowing the oil to flow through an orifice and counting the number of seconds required for a certain quantity to flow out. They are liable to become clogged with dirt, and so give bad results, even when much time is spent on cleaning the instrument before use. No agreement has yet been come to among operators as to the proper size of orifice to use, and results at present are usually relative and not absolute. Mr. Doolittle, chemist of the Philadelphia and Reading Railroad, has devised a viscosimeter on the principle of the torsion balance, of which we give a general view in Fig. 3. A steel wire, suspended from a firm support, is fastened to a stem, which passes through a graduated horizontal disk. A cylinder two inches long by one and a half inches in diameter is suspended by a slender stem to the end of the torsion wire and secured by a small thumb-screw. The oil is kept at a uniform temperature by being surrounded by a bath of water or paraffin wax. To start an experiment, the wire is twisted three hundred and sixty degrees by means of a knob at the top, and the cylinder then rotates in the oil by virtue of the torsion of the wire. The greater the viscosity of the oil, the greater will be the resistance, and hence the retardation. This retardation is a delicate measure of the viscosity of an oil which is expressed by the author in degrees of retardation per complete arc.

In order to secure freedom from error, two tests are taken—one by rotating the wire to the right, and the second to the left. For very accurate work, of course, it is necessary to determine the resistance in air and the resistance of the wire itself. These are readily obtained by first allowing the cylinder to rotate in the air and finding the amount of retardation under these circumstances. This gives a factor which is constant for a given instrument, and is deducted from the readings obtained in each experiment. The two advantages which this instrument possesses over other forms of viscosimeter are its independence of the gravity of the oil and of any reasonable amount of dirt which may get into it when in use.

Further experience has shown that, although the best method for expressing the viscosity where any one instrument is concerned is to take the number of degrees of retardation between the first and second complete arcs, where different instruments have to be compared it is far too delicate. Two instruments cannot be made to show the same number of degrees of retardation throughout a wide range of viscosity, unless such care and exactness are taken in the manufacture of the instruments as would add greatly to their cost. To obviate this difficulty each instrument is now standardized against pure cane-sugar solutions, the viscosity being expressed in the number of grammes of sugar contained in 100 c. c. of the sirup at 60° Fah., which will give the retardation designated at 80° Fah. These readings are obtained by taking a number of solutions containing known amounts of pure cane sugar and determining the retardation of each.

A curve is then plotted on a piece of ruled paper, the number of grammes of sugar in 100 c. c. of the different sirups representing the abscissæ and the degrees of retardation the ordinates. This curve enables the value of each degree of retardation to be interpolated in terms of pure cane sugar, and in this way a table of viscosities is drawn up and furnished with every instrument. Such a table renders the results obtained by different instruments strictly comparable.

Experiments with sugar solutions have shown the influence which specific gravity has on the determination of viscosity when made by the class of instruments which allow the liquid to flow through an orifice, the results being expressed in the number of seconds required to empty the vessel. The viscosity on the torsion viscosimeter of a certain oil having a specific gravity of 0·9 was found to be 86·4. A sugar solution was then made showing exactly the same viscosity, and its specific gravity was found to be 1·4. These two liquids having identically the same viscosity as shown by the torsion viscosimeter, but differing in specific gravity, were then run through a Saybolt viscosimeter. The oil required 35¼ seconds, while the sugar solution ran through in 30¼ seconds, thus showing that the difference in specific gravity caused an error of five seconds on the latter instrument by forcing the sugar solution through the orifice faster than the oil. To demonstrate still further the presence of this error, the viscosity of an oil of 0·9 sp. gr. was ascertained to be 35¾ seconds on the Saybolt instrument. A sugar solution was then made which gave exactly the same figure on the same viscosimeter, showing a specific gravity of 1·48.

The viscosity of these two liquids was then taken with the torsion viscosimeter, when it was found that the oil showed a viscosity of 86·8, while the sugar solution gave 91·8. In other words, it was necessary to make a solution of sugar of decidedly higher actual viscosity than the oil, in order to overcome the error due to difference in specific gravity. From this it would seem evident that the viscosity, as determined by any instrument based on the principle of allowing the liquid to flow from a receptacle through an orifice, has a very appreciable error due to the specific gravity of the liquid.

*Rideal and Youle's Viscosimeter.*—Dr. S. Rideal and W. E. Youle have also drawn attention to the fact that methods for determining the viscosity of liquids, based on the time of flow out of a burette, give misleading results unless special precautions are adopted. In a paper read before the Society of Chemical Industry (vol. x., No. 7), they discuss this subject at some length and describe a modified form of the apparatus devised by Slotte, which gives readings of viscosity of absolute value. Slotte's instrument consisted of two bulbs connected by capillary tubing. The bulbs were practically of the same capacity and were fitted with tubes, so that the liquid to be examined could be sucked over from one bulb to the other and back again. The capillary tube was continued upward into the first bulb for half its diameter, so that no correction is required for the effect due to gravity upon the liquid in the second bulb. The apparatus employed by Dr. Rideal is shown in Figs. 4 and 5 (for which we are indebted to the Society of Chemical Industry). It consists, as will be seen, of a bulb with an upper and lower constriction, to which is attached a length of capillary tubing *l*, which is prolonged by very wide tubing into a bottle holding the liquid to be examined.

By means of a water pump a large bottle is partially exhausted of air, the pressure being indicated by a gauge, and this reservoir is used for drawing the liquid up through the capillary tube until the bulb is filled and then down again until empty, by changing the connecting tubing. The time taken for the liquid to pass between the two constrictures is called the emptying and filling time respectively. The absolute viscosity, or "innere reibung," is given by the formula,

$$y = k \times g \times h \times d \times t$$

where $k$ is a constant for the instrument used, $g$ is gravity in C. G. S. units, $h$ the mean height through which the liquid passes, measured in centimeters, $d$ the density of the solution, and $t$ the time in seconds. The constant, $k$, depends on the dimensions of the instrument, and is equal to the value of the expression

$$\frac{\pi r^4}{8 l q}$$

where $q$ is the volume of the bulb in cubic centimeters, $l$ the length of the capillary tube in centimeters, and $r$ its radius. Instead of taking the dimensions of the apparatus and finding the value of $k$, one can find the time taken for water to flow out of the apparatus, and then using Poiseuille's value for water, the value for $k$ is determined indirectly. With very viscous solutions it is necessary to work under diminished pressure, as indicated above, if time has to be considered. Under these conditions, if HD represents the height and density of the mercury column in the pressure gauge, the formula becomes

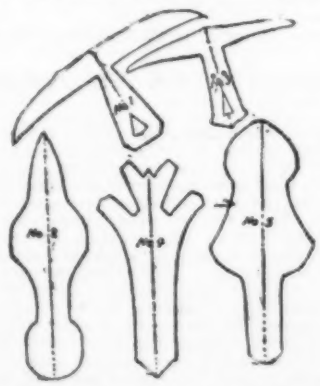
$$\eta = k\, g \left\{ \frac{t_0 + t_1}{2} \right. (\mathrm{HD} - hd)$$

For very exact results, a correction for the kinetic energy in the liquid has to be applied when the rate of flow is rapid, but if the time is considerable, then this correction may be neglected. The instrument works well with oils, but was first used for determining the viscosity of gum solutions.—*Industries.*

## PAPER BIRDS.

THE possibilities of home made amusement have been recently considerably extended by an invention of Mr. William A. Eddy, of this city. Mr. Eddy, with no other materials than a piece of paper and a paper of pins, has succeeded in making an aeroplane which flies with considerable success. This was only a few days ago, and now all Mr. Eddy's friends and acquaintances down town spend their luncheon hours in snipping out designs in paper, balancing them with pins, and sending the impromptu birds fluttering about in the air.

Anybody can make an aeroplane, although probably no one but a man who, like the inventor, has studied aerostatics for years would have thought of so simple a construction as the present one. There is no patent upon the invention, nor will there be one, because of its simplicity and the ease with which the floaters can be constructed. The original paper aeroplane is that numbered 1 in the illustration. Take a piece of light



paper about six or seven inches wide, cut it in the shape of the illustration, crease it lightly down the middle, weight it by sticking two pins through it in the places indicated by the dots, then stand on a chair and drop it. Instead of fluttering clumsily to the floor, it will go forward in a long, graceful swoop, and light gently at the other side of the room.

Now pick it up and slightly bend one of the wings. This time when liberated it swings gracefully around a circle, then circles again, reaching the floor after a course describing a perfect spiral. Bend the other wing and it circles in the opposite direction. This aeroplane is built after the model of the albatross, whose wing measurement is six times its length. It is known that the albatross can beat against the wind without motion of its wings, and Mr. Eddy thinks that some day an aeroplane that can do the same will be made. In the office of Coombs, Crosby & Eddy, at 78 South Street, is a big porter named Mike Collins. Mike was immensely interested in the aeroplane. Finally he ventured to ask for the loan of it to make one himself. The next day Mike appeared triumphant.

"I've cut a hole in my bird," he announced, "and sure he flies elegant and flutters his wings."

Mike showed the design numbered 3, and dilated on its merits. By noon every porter in the place had a "bird" of his own, and when the original inventor went down in the storage room to try a new design he found the men perched on bales and boxes challenging each others' "birds" to a race.

"I'll match the Pride of Erin agin' any bird that flies paper wings," announced one.

"I'll go you from here to the corner for a dime," responded another. "Here's backin' the American Eagle against the field."

"White Wings is in that." "I'll enter the Tailless Wonder." "Make way for Skyscraper."

There were a dozed entries in no time, all the aeroplanes being built on the same general plan, with minor variations in cut and weighting. It was an exciting race, but all the "birds" tended to curve, and only the "Tailless Wonder," a very large albatross, cut sharp behind, reached the corner. The contest suggested to Mr. Eddy that a flat aeroplane without wings would go more directly; so he constructed one on the plan numbered 2. Some of his friends to whom he showed it trifled with its shape until they evolved number 4, which is not so rapid, but very graceful, and with a decided tendency to exploration in nooks and corners. Then Porter Mike took a fresh hold and carved out the peculiar-looking bird seen in illustration 3.

This one did peculiar things, so he perforated it and made it still more eccentric. Now he's hard at work making new experiments on this general design, and expects to turn out something great presently. The other porters declare that if all Mike's prophecies come true, he'll construct a paper bird that will not only fly to order, but will sing "Hail Columbia" in time to the fluttering of its wings. Another good design is number 5, which is a rapid flier. It goes best when weighted with one very large pin close to the head. By perforating any of these aeroplanes they are made more steady, and if the perforations are small they seem to add to the buoyancy.

The designs given are a few of the very many made by Mr. Eddy and his friends. Mr. Frank J. French, of the *American Engineer and Railroad Journal*, has a fine assortment and is constantly making new experiments. All over the office buildings down town the idea has taken hold, and sailing these toy air ships bids fair to be the popular amusement of the day for business men. There are those, however, who look on it with suspicion. A few days since Mr. French and a *Sun* reporter went to the Borcel building on Broadway to try some of the toys from the seventh floor. A number of interested spectators gathered in the different galleries to watch the graceful course of the paper birds.

An albatross was first set off. It started with a long swoop across the open space, curved to the wall and

THE ALBATROSS IN FLIGHT.

fluttered along undecidedly; then made a dash for a pretty typewriter on the fifth floor, who put out her hand to catch it. But the aeroplane was not to be ensnared in beauty's net so easily. It wheeled, swept across the space again, made a beautiful long curve, and sank to the floor. After it, like a hawk after a pigeon, came a big "diver," one of the broad flat aeroplanes without wings. It reached the floor about the same time as the albatross, and fell at the feet of a middle aged man, who stopped abruptly and regarded it with suspicion. Turning his eyes upward, he beheld another one approaching. Then he went and called the janitor, who came in a hurry just as two more birds fluttered into one of the galleries, to the great delight of the spectators.

The janitor is a man without scientific instincts, but with a fully developed sense of his own importance. He examined one of the fallen birds, touched it with his foot, picked it up gingerly as if in fear that it might bite, and pricked his finger on the pin. Hastily dropping the bird, he climbed into an elevator and ascended to the seventh floor, where he found Mr. Eddy sending down more fliers. Fully impressed with the belief that the paper toys were in some occult way a menace to the building in his care and custody, he insisted that Mr. Eddy depart at once. In vain were the expostulations of the spectators. To their remarks and to all the bird flier's explanations he returned only abuse. In fact, he became very much excited and threatened to call in his assistants, the owner of the building, and the police. Then he rushed out to look for an officer, and rushed back again to make sure that during his absence one of the dreaded and mysterious paper things hadn't exploded and torn down the building. When Mr. Eddy and the reporter left the little janitor was furiously rushing about in concentric circles as if he expected by some magic process to evolve a policeman from the center. Mr. Eddy remarked that it was one of the incidental persecutions to which science was subjected, and that next time he would get permission of the owner of the building.

Thus far the paper aeroplanes have merely served as amusement; but Mr. Eddy believes that in their de-

velopment they will eventually solve the problem of aerial navigation. Experiments will soon be made in sending large aeroplanes down from a kite. When a motive power sufficient to hold a large aeroplane stationary against a head wind can be found, then, he says, the contrivance can be so weighted as to be lifted by the wind, and once lifted the weight can be shifted forward, and the machine swoop gracefully along in whatever direction is desired, as the paper birds do. This, he says, is still many years off. Meantime the little papers make an amusing and interesting toy on which numberless variations can be made. Get out your paper and shears and pins and try it yourself.—*N. Y. Sun.*

[Continued from SUPPLEMENT, No. 949, page 15174.]

## THE METHODS OF TESTING FATS AND OILS.*

By DR. ERNEST MAILLIAU, Director of the Government Testing Laboratory at Marseilles, France.

### FLUID VEGETABLE OILS.

*Olive Oil.*—Olive oil, like other vegetable oils, is a mixture of neutral glycerids, olein, stearin, palmitin, etc., and a variable quantity of free fatty acids. It is the edible oil *par excellence*, and the south of France owes a portion of its prosperity to the cultivation of the olive tree. This culture is to-day almost precarious in certain countries, though the consumption continually increases and olive oil always enjoys the just title of uncontested superiority. We can only attribute these remarkable results to the adulterations made for the purpose of selling under the name of olive oil, seed oils, or adulterated olive oils. We would be easily freed from these adulterations if chemists had at their disposition absolutely sure means to recognize them. Unfortunately the similarity of composition and reaction of the various vegetable oils render the demonstration of their presence extremely difficult. In face of the prejudice caused by adulteration, the greatest efforts have been made to solve the problem, and although the results have not been sterile, they have not yet reached a satisfactory solution. It is necessary to say that if certain adulterators succeed in selling seed oils disguised as olive, they reverse the problem for the chemist by making him seek olive oil in seed oil. I may remark that the fraud is not always so great. Very often the proportion of seed oil is not higher than 10 per cent. Consequently, for our methods of analysis to be considered absolutely good, they must give results without recourse to comparisons which are satisfactory to show 5 per cent. in a mixture. Under these conditions we will be certain to discover adulteration when made in the proportion of 10 per cent.

Let us rapidly review the general processes for the recognition of arachide, sesame, cottonseed, and poppy oils in olive oil; and we must acknowledge that none of them demonstrates less than 10 per cent.

*Specific Gravity.*—The specific gravity of olive oil varies from 0·915 to 0·918; we have 0·917 to 0·918 for undecorticated peanut, 0·921 for decorticated peanut, 0·923 for sesame, 0·921 to 0·924 for cottonseed oil, 0·924 for poppy oil. These variations of density in the olive oil do not allow us to recognize a mixture with any degree of certainty.

*Action of Nitrous Fumes.*—When taken from the water bath, if the oil contains a fairly large proportion of peanut oil, it will appear wine red. Pure olive oil is, on the contrary, lemon yellow. When taken from the cold bath a complete solidification is observed with pure olive oil, which has the appearance of very light fresh butter; with a mixture of 15 per cent. of all other oils there is no solidification. This method gives good means of detecting peanut and poppy oils in edible oils, but is of less use when applied to oils used for industrial purposes, which may not solidify, though pure.

*Sulphuric Saponification.*—The rise of temperature of olive oil is 35°; the relative, 94°. A rise of temperature above 35° usually indicates adulteration. Equal or lower results do not absolutely indicate purity, because certain pure olive oils give only 31°, 32°, and 33°, and, in consequence, after the addition of seed oil, show only 34° to 35°.

*Indices.*—The iodin number varies from 80 to 85, and in a certain measure helps us to discover seed oils. It likewise offers us a quantitative method with a mixture of known oils. The variations in composition of the same oil vitiate its sensitiveness for determining mixtures from 5 to 10 per cent.

We will not mention the other general processes, but will dwell particularly on the special reactions which characterize the presence of three oils most frequently used to adulterate olive oil, to wit: peanut, sesame, and cottonseed.

These processes have a much greater analytical value than the general ones, for if in the course of analysis we find unsatisfactory results with the latter, we can detect adulterations with certainty by the former.

*Examination for Peanut Oil.*—The density is almost the same. The sulphuric saponification, and above all the Cailletet process gives us good results, but only the presence of arachidic acid $C_{22}H_{44}O_2$ (melting point, 75°) allows the sure recognition of the presence of peanut oil. We have adopted, with slight modifications, the method of Renard. Twenty grammes of the oil are saponified by 20 cubic centimeters of a caustic soda solution of 36° B., diluted in 100 cubic centimeters alcohol 90 per cent. The soap formed is precipitated by a 50 per cent. solution, in alcohol, of lead acetate, which must be neutral. After complete precipitation, decant while warm, and wash the residue with alcohol, which after being ground in a mortar is agitated with 200 cubic centimeters of ether. This operation is repeated three times to remove the last traces of lead oleate soluble in ether. The residue is then put in a porcelain dish containing two or three liters of distilled water and 50 cubic centimeters hydrochloric acid. When decomposition is complete the solution is decanted and the fatty acids washed with distilled water, after which they are dried in an oven to remove the last traces of water, when they are dissolved in 40 cubic centimeters of 90 per cent. alcohol. A drop of hydrochloric acid is added and the mixture chilled to 15°. Peanut oil gives a generous deposition of arachidic acid crystals. These are washed twice, using 20 cubic centimeters each time of 90 per cent. alcohol, then three times with 20 cubic centimeters each time of 70 per cent. alcohol, in which arachidic acid is completely insoluble. The washing is complete when a few drops give no residue on evaporation. The acids are warmed slightly and treated with boiling absolute alcohol. After filtration the alcohol is evaporated in the oven at 100°, till the weight of the residue remains constant. If the melting point of the residue is between 73° and 75°, we can affirm the presence of peanut oil. We must be sure of the freedom of the fatty acids from all traces of oleic acid, which prevents their crystallization. This elaborate but truly scientific process must be carried out only by skilled hands.

*Examination for Sesame Oil.*—To recognize sesame oil in olive oil we can use the specic gravity, the sulphuric saponification and Cailletet process, but especially the method which we use in our laboratory, and which consists of the reaction of hydrochloric acid and sugar upon the fat.

We do not operate on the glycerid, but on the derived fatty acids. If the oil is operated on directly, we can obtain a red or pink coloration with a perfectly pure olive oil. I have frequently observed this coloration in my laboratory with olive oils from Tunis, Algiers, Molfetta, Bitonto (Italy), and more rarely with those from Provence. This coloration comes from the coloring matter dissolved in the juice which flows out along with the oil from the presses. This can be shown by treating the separated juice with hydrochloric acid and sugar, with which it gives a coloration exactly resembling that given by sesame oil. It is, therefore, of the highest importance to work with pure fatty acids, according to the process I am about to describe, and which has been called the Maillian process.

*Method of Operating.*—We saponify fifteen cubic centimeters of the fat under examination with ten cubic centimeters of the solution of caustic soda, 36° B., with the addition of ten cubic centimeters ninety-two per cent. alcohol. When the boiling mixture becomes clear, we add 200 cubic centimeters hot distilled water and boil to expel the alcohol; then decompose with ten per cent. sulphuric acid. The fatty acids are removed from the surface in the pasty state and washed by shaking in a test tube with cold distilled water, after which they are heated in an oven to 105°. When the greater part of the water is eliminated and they commence to melt, we pour them on half their volume of pure hydrochloric acid, which has been saturated in the cold with finely pulverized sugar. The mixture is shaken violently in the test tube. The presence of sesame is always distinctly indicated by the rose or red coloration of the acid solution; other oils leave the acid colorless or communicate to it a slightly yellowish tinge.

This reaction is extremely delicate and permits the sure recognition of the presence of one per cent. of sesame oil, not only in olive oil but in all fatty mixtures, as well as in soap.

This process was presented before the Academy of Sciences by M. Debray, February 20, 1888, and was awarded the gold medal of the Societe d'Encouragement. (Report of M. Muntz, in the name of the Agricultural Committee, February 20, 1889.)

*Examination for Cottonseed Oil.*—Until recently the detection of cottonseed in olive oil was considered impossible, and accordingly, the different scientific societies and several chambers of commerce promised great prizes to the inventor of a process which would detect this adulterant.

Two methods were proposed simultaneously—one by M. Bechi, the other by myself. These two processes, which at first sight appear quite analogous and based upon the same reaction, differ completely from the scientific standpoint, as well as in the exactness of the results obtained. M. Bechi has based his process upon the direct action of silver nitrate upon the oils. As long ago as 1878, we made some experiments with M. Puget of a similar nature, and the uncertainty of the reactions led us to abandon them entirely.

M. Bechi's process possesses the serious inconvenience of causing us at times to reject as adulterated, oils which are absolutely pure, and thus work injustice and create a considerable prejudice against the firms which have sold them. From results obtained at the Institut National Agronomique of Paris, as well as in other laboratories, a deep coloration has been found with oils absolutely pure. Outside of these inconveniences, which are sufficient to cause us to throw it aside, it has a defect of being based upon a coloration having no well-defined chemical character, and it produces effects with different substances, the action of which it is impossible to explain. The use of colza oil has the serious fault of bringing into the reaction a second oil which may be impure and completely vitiate the results. Finally, the conclusions reached by the Italian scientific commission, instituted at Rome by act of the ministry to study the Bechi process, show that it is not certain on quantities of less than fifteen per cent. It solves the problem of finding less than ten per cent. no better than the Cailletet process, which shows the presence of fifteen per cent. The same commission declared also that olive oil containing glycerin, free fatty acid, formic acid, acetic acids, does not give a sure reaction with the Bechi reagent. Now, since all olive oils contain free fatty acid, from several tenths of one per cent. for virgin oil to 100 per cent. in some industrial oils, what conclusions can we reach?

The Bechi process will give, from fifteen per cent. up, a brown coloration of variable intensity, but in oil containing cottonseed oil, which is fresh and well refined, the only sort used for edible purposes, we have a very weak reaction; while with an olive oil perfectly pure, but containing organic or mineral matters in suspension or solution, which have an action upon the reagents, we should have a pronounced coloration.

That is why I gave up these uncertain and variable results obtained in 1878 and studied the action of the nitrate of silver, not upon the oil itself, but upon the products of saponification derived from it. The results obtained exceeded my expectations, and have been published by the press as the Mailliau process.

*Mailliau Process, Mode of Procedure.*—In a porcelain dish of 250 cubic centimeters capacity, fifteen cubic centimeters of the oil to be investigated are heated to about 110°, then there is slowly poured on the oil a mixture of ten cubic centimeters of a solution of caustic soda of 36° B. and ten cubic centimeters of alcohol of 90° B. When the mass boils it becomes clear and homogeneous; 150 cubic centimeters of hot distilled water are added and boiling continued to expel the alcohol. The fatty acids are displaced with ten per cent. sulphuric acid solution added in slight excess, and the pasty acids immediately collected with a small platinum spoon. They are washed by shaking several times in a test tube with an equal volume of cold distilled water. The drops of water are drained off and they are then poured into a tube 2·5 centimeters in diameter and 9 centimeters long; 15 cubic centimeters of alcohol ninety-five per cent. and 2 cubic centimeters of three per cent. nitrate of silver solution are added. The tube is protected from the light in the water bath at 90° C. until about one-third of the alcohol is expelled, which is replaced by 10 cubic centimeters distilled water. The heating is continued a few minutes and the coloration of the insoluble fatty acids is observed. *The presence of cottonseed oil in any proportion whatever causes a mirror-like precipitate of metallic silver, which blackens the fatty acids of the mixture.*

The members of the agricultural committee, composed of the greatest savants of France, MM. Pasteur, Eug. Tisserand, Boitel, Chatin, Heuge, Hardi, Rissler, Schloesing, Ronna, Lavaland, Muntz, Prillieux, Maret, Hon. Baron Thenard and Liebaut, after having tested the process on 128 samples from different provinces, have had the kindness to confer upon me the gold medal for this method of analysis, and I will take the liberty to present the conclusions of their secretary, M. Muntz, director of the laboratories de l'Institut National Agronomique: "The preliminary saponification applied to the examination of fatty matters constitutes a new method on which we can confidently rely, not only in the analyses of edible products, but also of those used for industrial purposes and also for soaps." (February, 1889.)

Before proceeding with this monograph, it is, of course, well understood that the same processes can be used for the detection of peanut, sesame and cottonseed oils, in all other fatty mixtures.

*Peanut Oil.*—Peanut oil, apart from the arachidic acid which it contains, presents no special characters, as you can observe by examination of the chart upon which are indicated its physical and chemical properties.

*Sesame Oil.*—The purity of sesame oil may be demonstrated by shaking 10 cubic centimeters of oil, first with five drops of sulphuric acid of 53° B., then with five drops of nitric acid of 28° B. The oil undergoes a progressive change of color through various shades from light green to red. The final red coloring matter obtained by this oxidation process turns yellow by the action of alkalies and returns to its original color with acids. This curious phenomenon does not take place with other oils, but is obtained sometimes when working on sesame oils slightly adulterated; besides, the industrial oils from hot pressing, though pure, may give negative results. I have devised a rapid process, especially applicable for the recognition of castor oil in the industrial sesame oils.

*Mailliau Process.*—For the rapid identification of castor oil and sesame, ten grammes of the oil are shaken up with four drops of sulphuric acid of 66° B., a drop of nitric acid of 40° is added and shaken violently. Pure sesame oil blackens immediately, while that containing castor oil remains turbid yellow.

*Cottonseed Oil.*—Concerning this oil, from a chemical standpoint, we have nothing particular to say. From the industrial point of view we may state that this product becomes more useful every day. Its cheapness allows everybody to use it, and this fatty material daily augments its important place in the markets of the world.

We will pass rapidly over the drying oils, poppy seed, linseed, walnut, cameline, over those of the cruciferæ, colza, rape and mustard, as well as the oils of the sweet almond, hazel nut and castor, the properties of which are shown upon the chart.

I will take the liberty, however, of mentioning a rapid process which I have devised for detecting the presence of castor oil in other oils. It is well known that the oils in general are soluble in petroleum ether, while castor oil, which distinguishes itself by its solubility in alcohol, is likewise remarkable for its insolubility in petroleum ether. Unfortunately this insolubility disappears at the ordinary temperature when a soluble oil is adulterated with a small proportion of castor oil.

It is only necessary to demonstrate its insolubility by shaking in a test tube one volume of the oil to be examined with two volumes of petroleum ether, and cooling the mixture to —16° C. At the end of a few minutes the mass coagulates, and the oil separates if castor oil is present, while the liquid remains homogeneous if it is pure. This phenomenon is especially curious, because it will be noted that the freezing point of castor oil unmixed with petroleum ether is much lower than that of most other oils.

### SOLID VEGETABLE OILS.

*Cocoanut and Palm Nut Oils.*—The production of these oils, which is continually increasing on account of their extensive use in the manufacture of soap during the last few years, has been made the object of several adulterations. Independently of the general chemical and physical character of these oils, as well as the sulphuric saponification which I have mentioned, we can employ with good results the determination of the saturation equivalent with normal caustic soda solution.

These oils, containing a greater amount of the lower fatty acids, require for their saturation a larger quantity of sodium oxide. To recognize these oils, it is only necessary to determine the number of cubic centimeters of normal solution required for the saturation of five grammes of the pure fatty acid, viz.: Cocoanut oil, 24·1; palm nut oil, 22·5; while the average of the other liquid oils is seventeen to eighteen cubic centimeters only. This process presents some inconveniences, especially when trying to discover adulteration in small quantities, because it must be noted that

* Read at a special meeting of the Chemical Section of the Franklin Institute, June, 1893.—*From the Journal.*

the adulteration of these oils is practiced only within certain limits, otherwise their appearance would lead to its detection. Besides, when an oil is made from old or spoiled seeds, the saturation is a little less.

Since the detection of adulterations in these oils depends on variations of a few tenths of a centimeter which might be caused by variations in quality of the oils themselves, or the method of operating, it is necessary to be very circumspect in the use of this truly scientific process.

With palm nut oil this error might be greater, because it is customary to balance the low saturation of the seed oils by the addition of cocoanut oil. As, for example, five grammes of fatty acids from a mixture containing forty-five per cent. of palm nut oil, forty-five per cent. cocoanut oil, and ten per cent. peanut oil, require precisely 22·5 cubic centimeters normal solution for their saturation.

*Iodin Number.*—This determination is very useful because these oils, being very rich in saturated acids, absorb much smaller quantities of iodin than most other oils. For example, peanut gives ninety-seven, while cocoanut and palm nut show only nine to sixteen. Unfortunately, this difference of seven between the maximum and minimum throws us out of the way for small quantities of admixture, so much so that different authors fail to agree upon the average variation; some giving eight to nine only, while we are accustomed to find from thirteen to fifteen.

To recapitulate, this process, which if it gave constant results would be excellent, fails to give sufficiently accurate indications to detect adulteration of cocoanut oil when in small proportions. It is worse with palm nut oil and of no value to distinguish between the two.

Continuing our investigations in another direction, we have fortunately found a process which gives constant results when used upon these oils after a preliminary neutralization.

We have discovered that cocoanut and palm nut oils are entirely soluble in absolute alcohol. At a temperature of 30° to 31° C., the former requires two volumes and the latter four volumes for complete solution.

It is a curious phenomenon that the smallest addition of vegetable or animal oils destroys this solubility in the same quantities of absolute alcohol. The solubility of the mixture is not proportional to its composition, but the mixture acts entirely like a distinct body.

*Mode of Procedure.*—First operation: Twenty cubic centimeters of the oil are shaken in a test tube with forty cubic centimeters of ninety-five per cent. alcohol. This indispensable preliminary treatment may give certain indications. Oils soluble in ninety-five per cent. alcohol, castor and resin oil, etc., are thus discovered, while mowrah and karite oils give a milky turbidity to the alcoholic stratum.

Second operation: Five cubic centimeters of the neutralized cocoanut oil are measured with a pipette into a graduated test tube and ten cubic centimeters absolute alcohol added. The temperature is raised to 31°, the tube shaken violently for half a minute and then immersed in a water bath kept at a temperature slightly above that of the tube.

Pure cocoanut oil dissolves completely and the solution remains clear. Any addition of another fatty matter causes precipitation; the material in solution being in a state of molecular equilibrium, which is destroyed by the slightest modification.

Cocoanut oil containing palm nut oil precipitates when the proportion of the mixture amounts to twenty per cent.; below this the mass remains turbid.

The verification of palm nut oil is made in the same manner, only using twenty cubic centimeters absolute alcohol instead of ten, temperature remaining the same, 30° to 31°. Five cubic centimeters of palm nut oil containing twenty per cent. or more of cocoanut oil dissolves in fifteen cubic centimeters of absolute alcohol. In the same proportions pure oil does not dissolve, and the mixture remains turbid.

A mixture of cocoanut, palm nut and peanut oils, in such proportions that the oil would appear pure by the indices of saturation, would easily be discovered by this process.

If we work at a lower temperature, the proportion of absolute alcohol must be increased. For example, at 25° to 26° it is necessary to double the quantity; for five cubic centimeters of cocoanut oil, use twenty cubic centimeters of alcohol, and for the palm nut forty cubic centimeters.

The same method may be used to determine the purity of cocoanut and palm nut cakes by first extracting the oil by means of a solvent and then operating on it in the manner described.

This process, which I have had the honor to describe, when carefully executed, enables us to determine in a few minutes adulterations of these oils which might cause bad results in soap making, which employs hundreds of millions of kilogrammes per annum, and in agriculture, which uses the cakes for cattle food. This process was presented to the Academy of Sciences, October 12, 1892, by M. L. Troost, and has been the subject of a favorable report to the Minister of Agriculture.

Let us pass rapidly over palm oil, of which the principal chemical properties are not remarkable, except its partial solubility in absolute alcohol, which is ten per cent. Also we will pass over the mowrah, which, as I have already mentioned, is identified by the milky-white turbidity which it communicates to alcohol by shaking.

*Illepi Oil.*—This product, the titer of which is 52·5°, and cottonseed margarine, or stearine as it is called here, whose chemical reactions are the same as the oil itself, will not long detain us.

While closing the description of the solid vegetable oils, I wish to mention karite oil, which comes from the French province, Soudan, which I have been especially directed to investigate by the Chamber of Commerce of Paris and the chamber of the syndicate for the manufacture of soap and candles.

It was very important for us to know how to utilize the great forest which covers the largest part of French Soudan. It is composed chiefly of the wild acacia and the karite or butter tree. The natives collect the nuts which fall from the trees, crush the kernels, treat the pasty mass with boiling water, and skim off the fat which comes to the surface. This fat, which is solid at the ordinary temperature, is used as an edible butter.

Without speaking about the great uses to civilization of this product, I must mention its remarkable chemical properties. The fatty acids, having a titer of 52·5° C., combine with soda to produce an extremely hard soap. For candle making they would probably give better results after preliminary treatment to remove the resinoid matters which they contain and which hinder the crystallization of the fatty acids.

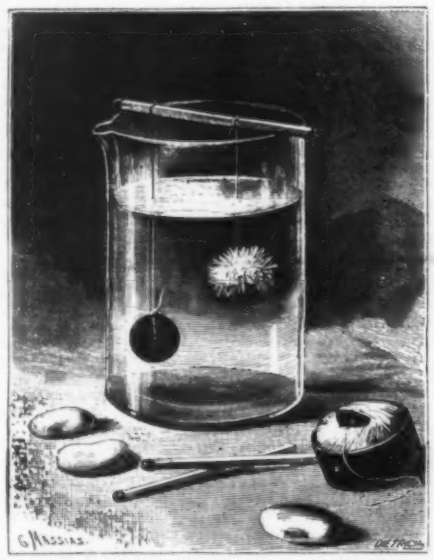
The presence of these resins lowers the saturation to 14·9, and, like the mowrah, this oil causes turbidity by shaking with alcohol. (Communication of M. Mailliau to the Société d'Encouragement of Paris in 1892.)

*(To be continued.)*

## EXPERIMENT ON THE CRYSTALLIZATION OF SULPHATE OF SODA.

DURING the course of some researches that I am making at the present moment upon the swelling of seeds I have been led to perform an interesting experiment that is easy to repeat with common objects. The following is the *modus operandi*. Into any vessel whatever put some water along with a certain quantity of sulphate of soda, which may be easily procured at any drug store. Stir for a certain length of time until it is judged that the solution is saturated—a fact that may be known by observing that the crystals no longer dissolve. A portion of the liquid is now decanted into another vessel, in leaving the undissolved crystals behind. Then attach a kidney bean to a thread and do the same with a non-porous object, such as marble, a pin, or a piece of glass. Upon the rim of the glass place a match horizontally and attach the two threads to it, so that the two objects that they support shall be immersed in the liquid.

In a short time we shall see emerging from the bean small crystals of sulphate of soda, which will increase and radiate in all directions, in rapidly growing in length. The non-porous object exhibits none of these phenomena. It looks as if the bean, which assumes the aspect of a sea urchin, had a very special partiality for the sulphate of soda and attached the latter to it; but, of course, this is so only in appearance. The explanation of the experiment is more commonplace:



EXPERIMENT ON THE CRYSTALLIZATION OF SULPHATE OF SODA.

the bean in swelling does not absorb the solution such as it is, but only the water that it contains, with a very little of the salt. The result is that, all around the bean, the solution, losing its water, becomes supersaturated and allows its crystals to deposit. It is a true evaporation in the interior of the seed.—*H. Coupin, in La Nature.*

## THE ESSENTIAL OIL OF LEMON.

By R. S. LADELL.

MANY plants contain oily substances to which they owe their peculiar odor, and which can be obtained from them by distillation with steam. Many of the so-called essential oils contain terpenes or hydrocarbons represented by the formula $C_{10}H_{16}$; and it has been stated that the terpenes are often the chief constituents of the essential oils, as in the case of lemon and orange oils, etc. But it should not be forgotten that the oils of lemon and orange, as well as other essential oils, may be obtained entirely devoid of terpenes.

Geissler (*Pharmaceutische Centralhalle*, 1881) has described the terpeneless oil of lemon, and shown that it excels the commercial oil of lemon in odor, flavor, stability, solubility and strength. The true terpeneless oil of lemon, which is the subject of this note, is an oxygenated liquid of constant boiling point, specific gravity, and composition. Commercial oil of lemon has a specific gravity of 0·860 at 15° C.; the terpene known as citrene has a specific gravity of 0·850; while the *ordinary* terpeneless oil of lemon (*i. e.*, freed from citrene) has a specific gravity of 0·900. The ordinary terpeneless oil of lemon is really a mixture of several oxygenated compounds, but by fractional distillation a liquid has been obtained which has a constant composition, an exceedingly strong odor of lemon oil, a specific gravity of 0·962, a boiling point of 206° C., and a specific rotatory power of $[\alpha]_D = +6{\cdot}42°$. The following results were obtained on submitting this liquid to analysis: 0·5313 grm. gave 1·5135 grm. of $CO_2$ and 0·5617 grm of $H_2O$.

| | Found. | Calculated for $C_{10}H_{16}O$. |
|---|---|---|
| Carbon | 77·6 | 77·92 |
| Hydrogen | 11·8 | 11·68 |
| Oxygen | — | 10·40 |

The above figures correspond with the empirical formula $C_{10}H_{14}O$ for the *true* oil of lemon—that is to say, for the terpeneless oil of lemon of constant composition. This oil appears to be an isomer of borneol. Further investigations are in progress, the results of which will be published in due course.—*Chemical News.*

## SASSAFRAS TREES.

By WALTER J. QUICK, Columbia, Mo.

As being of some scientific interest, it is worthy our attention to note the marvelous growth that ten trees of the above well known variety have acquired here in Missouri—a growth that is so exceptional of this species that it has not been observed elsewhere in the United States.

The *Sassafras officinale*, of the order *Lauracea*, the laurel family, is very seldom known as little more than a shrub or bush and generally as growing poorly or not at all on fertile soil. In truth, it is looked upon as being in its native element in company with and growing on thin land. This is not a fact, but the opinion prevails since old and worn-out fields, depleted of their fertility in greater part, when abandoned, grow up to "brush," not the least profuse of which is the sassafras. It is a native of America and has been found in every State in the Union, growing much more abundant on poverty-stricken soil, but more luxuriant and larger in proportion, we conclude, as the per cent. of humus in the soil increases. In the poor, white clay lands of the New England States and some parts of Indiana, Kansas, and this State we have observed it growing where it seems to sprout profusely and does not reach a height of over 12 ft., usually 6 or 8 ft., while in the same States on richer land it will not be found in thick profusion, but scattered and attaining almost to the dignity of a tree in size.

Recently it was our pleasure to visit the beautiful farm of Mr. T. B. Hickman, near Columbia, Mo. During our stay we were shown the various interests of the owner, and our attention was summoned to some peculiar trees of the sassafras variety. Their difference from others of this species consists in their vigorous growth and extreme size, being the largest any one present had ever seen or of which we had in any way known. This preternatural development inspired us to investigation. They exhibited on measurement the surprising circumference of 80 to 82 in.—a diameter of over 26 in. As the bark is thick and rough, similar to walnut, the diameter of the solid wood is not likely this much, but fully 2 ft. By triangulation we ascertained the height to be about 55 ft., and the whole ten will not vary much from these measurements.

While there is very little indication of decay, as a matter of fact these trees are fully grown for this variety. Their location is very auspicious for the growth they have made, being the low, rich and moist soil of Bonne Famme creek bottom. The writer has never seen larger trees, and is unable to learn of larger specimens on this continent, with the exception of the species of sassafras of California and the western slope of the Rocky Mountains, known as *Oreodaphne Californica*, which attains a still larger size in "the land of big trees." The aroma from the leaves of this variety is more pungent: in fact, so much so as to occasion excessive sneezing, frequently during high winds. It has a greater reputation medicinally than ours, though the importance of the latter is by no means small.

Our *officinale* species has been introduced into England as *Sassafras laurus*. As is usual with anything imported, they appreciate it more as medicine than we do. A tree near the Royal Gardens at Kew has attained a height of about 50 ft., and is said to be over 110 years old. As there are no other figures given, we cannot compare the size with that of the Hickman trees, but the height is not so great.

Almost every country has one or more species of this tree, all said to differ in some characteristic from ours, but all having the same odor and similar aromatic, sweetish taste. But one country has larger trees. Those of New Zealand grow to a height of 100 to 150 ft. This tree appears in every clime, and is described as having "a large head of horizontal branches." The fruit is a small, black drupe, which is not palatable, but is eaten by birds. The sassafras oil of commerce is made from these seeds and the buds. The leaves of our species are very dark green, rather thick, broad, oblong and elliptical.

In Italy it is more like the American species than any other, and is known as *Sassafrasso*. The word comes from the Latin, *saxum*, a stone, and *frango*, I break, so named because it was believed that the use of the tea made from it would dissolve the gall stones of the bladder and prevent their formation.

In the Southern States sassafras grows to the size of trees, generally small, but very abundant. The air is said to be more pregnant with its aroma than further north, and it can be detected a great distance at sea. The bark seems to be more fragrant, too, when steeped.

Sassafras tea is very popular in many sections of the countries where the tree grows. The bark of the roots is kept everywhere for sale, for that purpose. In addition to its use as a table beverage it is employed as a tonic and constitutional stimulant. In those localities where the sugar maple tree is a native and abundant, a very delightful drink is made from the "sugar water," or sap and bark of the sassafras root. It makes the finest tea in the spring when the sap is forming, and is then drunk mostly to resuscitate the system, improving the appetite and aiding the digestion. It is also valuable for boils, pimples, and eruptions of all sorts, as well as for rheumatism.

The pith of the new growth and sprouts contains a gum or mucilage, used in eye medicines, as being important in reducing inflammation and granulations. This product is also prepared in the form of a drink for diseases of the kidneys, catarrhal troubles and dysentery.

In many localities there is perhaps no more popular farmers' remedy for disease of horses. It is administered by grinding the root bark to a powder and giving it in the feed, or by preparing a decoction with which the feed is mixed. Frequently the roots are placed in the horse's feed trough, and he is permitted to bark them himself, which he willingly does, apparently with much relish. In the spring it greatly improves his ap-

petite, strengthens him, and assists in shedding and sleeking his coat.—*Science.*

## HORTICULTURAL AND VEGETABLE NOVELTIES OF THE SEASON.

A RECENT number of the *Gardeners' Magazine* contains an illustrated article on this subject from which we make the following abstracts.

### AQUILEGIAS.

This interesting class of old garden flowers has not of late received any great attention at the hands of our own florists, but our continental friends patiently pursue their investigations and experiments, which

AQUILEGIA VERVAENEANA ATRO-VIOLACEA PLENISSIMA.

sometimes result in the discovery of a new species, the production of good hybrids or the fixing of an improved variety. MM. Vilmorin, Andrieux et Cie., Paris, are offering seed of a race of hybrids obtained by crossing A. chrysantha with A. cœrulea; the flowers are large and erect, and contain various shades of yellow, rose, violet, copper, and yellow. For every purpose this strain—hybride de cœrrulea variée—is extremely useful, and easily cultivated. The Parisian firm also offer a white variety of A. flabellata, which they recommend for pot culture and forcing. Chr. Lorenz, Erfurt, offers a handsome aquilegia, which has everything to recommend it but its name; we give an illustration of this novelty, which is catalogued as Aquilegia Vervaeneana atroviolacea plenissima. This form has large and very double flowers of a dark violet color; the foliage is handsomely variegated, and the habit is decidedly elegant.

### BEGONIAS.

All the firms which make begonias a specialty have this year introduced many excellent new varieties, and some distinct novelties. Messrs. J. Laing & Sons have among other fine double-flowered kinds, Duchess of York, rich rosy red, of erect habit; Duke of Fife, salmon pink, a handsome variety; Gigantea, enormous

BEGONIA SEMPERFLORENS, DUCHESS OF YORK.

salmon colored flowers; Mrs. Regnart, a grand double yellow, which attracted much attention at the last Temple show. Besides their large and excellent collection of named tuberous begonias, this firm have a unique collection of the handsome Rex begonias, including the recent additions, of which several have very highly colored leafage. Messrs. H. Cannell & Sons are well known as cultivators and raisers of new and meritorious begonias; a few of their best recent introductions are Hector, a grand scarlet flower of deep form; Lord Llangattock, with enormous velvety scarlet flowers; and R. B. Parsons, a remarkable plant of splendid habit, and bearing numbers of fine double flowers of a delightful shade of bright rosy pink. Fashion is a single variety of wonderful free habit, and has old gold colored flowers shaded with yellow. Mr. T. S. Ware, of Tottenham, has made vast strides in the improvement of begonias, and has this year some magnificent varieties, notably Elegans, which is a new departure in the carnation shaped forms, the edges of the petals are wavy and crisped, and the color is salmon pink shaded with yellow; Miss Jennie Fell is a charming addition to the camellia flowered section, and is of a rich crimson hue. Mrs. F. Fell bears the largest flowers of any we have seen, and these are an exquisite shade of salmon rose; Duchess of Teck is one of the finest double yellows. Duke of Teck, a particularly large and gorgeous crimson scarlet variety. Ada Allward is a handsome variety of a section which the Tottenham firm has devoted much attention to; the center is pure white surrounded by rich salmon. The illustration admirably depicts this variety. Picotee is another lovely new production, the ground color being pure white, while the segments are prettily edged with pink. One of the most elegant and pleasing begonias we have seen. Mr. J. R. Box, Croydon, has long been associated with the progression in begonias, and his new varieties show decided improvement. Mrs. Jenkins is a grand double yellow, distinct in habit and with large flowers; Lady Beatrice Herbert is a lovely double salmon pink, and Hon. Sydney Herbert is a broad petaled double form of deep rosy carmine color. A new begonia has been introduced by Messrs. J. Veitch & Sons, Chelsea, from the East Indies. It is a very dwarf species with beautiful small bronzy green leaves, like velvet, through which run the veinings, which are of a yellowish green color. This handsome stove begonia is named B. decora, and is well worth the notice of those who can accommodate it. Messrs. Sutton & Sons, while not behind in their selection of tuberous rooted begonias, have recently devoted a large amount of attention to the fibrous rooted semperflorens varieties, one of which—a charming variety named Duchess of York—we have the pleasure of figuring. The delicate carmine tinted flowers of this have attracted considerable attention of late. A companion novelty is Sutton's Coral Gem, which blooms profusely, being, when well grown, literally covered with rosy peach-colored flowers. The semperflorens begonias are remarkably free in blooming, and after being bedded out during summer they can be lifted and potted, when they will provide a display in a warm house during winter.

### DAHLIAS.

The taste for light forms of flowers has now become so fixed that the symmetrical florists' flowers which

SINGLE CACTUS DAHLIAS.

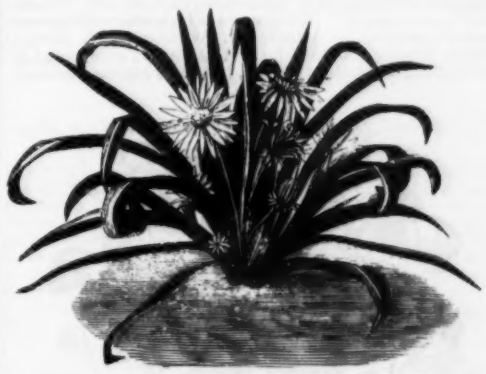
passed muster a few years back have now for indoor decorations to give place to elegant and graceful forms. Thus, in the dahlia we have retraced our steps, seeking for new things all along the path; the show dahlias are usually discarded for that purpose, but the cactus, decorative, pompon, and single varieties remain, and the less formal section has the greatest number of devotees. The illustration of the new single cactus dahlias we are enabled to give through the courtesy of Messrs. Dobbie & Co., Rothesay, who have been the introducers of this section, which originated with E. J. Lowe, Esq. These dahlias are less formal than the single kinds, and the colors, considering the short time Messrs. Dobbie & Co. have taken to develop them, are remarkably diverse and striking. This informality will be a detraction from merit in the opinion of many, but as we have indicated above, the taste for artistic outline and graceful habit has become so pronounced that to say their popularity will be great in the immediate future could hardly be called a prediction.

### DELPHINIUMS.

These superb hardy perennials have been brought to such perfection during recent years that one hardly deigns to look at the old varieties which decked our gardens ten or fifteen years ago. As the season comes round we look for the displays of delphiniums just as at a later period we look for chrysanthemum shows, but while to assist in the progress of the latter there are innumerable firms and numberless private growers at work, there are few who have worked to improve the delphinium. The improvement has nevertheless been made, and all who from time to time have had the opportunity of noting it, have marveled at the result obtained almost single handed by Messrs. Kelway & Sons, of Langport, Somerset; we would willingly divide honors, but there being no competitors, this firm carries off the palm. Blue in its multitudinous shades is the color most frequently met with now, but we hope that Messrs. Kelway & Sons will shortly give us some distinct color through the medium of the yellow D. Zahil they exhibited a year or two ago. A few of the new delphiniums offered this season are John Thorpe, a brilliant blue semi-double with white center very handsome; Geneva, sky blue and mauve with white eye; Kenneth, deep blue, with a black center; Ultica, deep violet and purple with darker center; and Burlington, plum color, edged with blue prettily relieved by the white eye. Washington is a handsome single variety, violet and plum color, white center.

### GAZANIA.

It is some time since any novelty has appeared in the now somewhat neglected genus of gazania, but we have



GAZANIA NIVEA.

now to record the introduction of a new species from Natal. Gazania nivea may be grown as a greenhouse plant or cultivated like many other half hardy plants, and placed out of doors in the summer time. The accompanying illustration given by the courtesy of Chr. Lorenz, Erfurt, Germany, affords a good idea of the plant's habit. It grows about one foot in height, and produces numerous large composite heads of flowers. The ray florets are broad and pure white, while the disk florets form a compact dark yellow center. Gazania nivea is worth the attention of all who desire to possess a novelty and wish to include a distinct new plant among their garden treasures.

### NICOTIANAS.

This year we have to record a variegated form of this striking and handsome half hardy plant. We first

NICOTIANA COLOSSEA VARIEGATA.

made the acquaintance of Nicotiana colossea variegata at the Ghent exhibition of 1893. This novelty is grown extensively at Messrs. J. Laing & Sons, Forest Hill Nurseries, and one of their plants is figured in the accompanying illustration. The several shades of green in the massive leaves contrast in a striking manner with broad creamy margins and the silvery patches which shade into gray and green. We have also observed a form of Nicotiana affinis with creamy variegated foliage, but so far as we have seen, it is less vigorous than the type.

### SAINTPAULIA IONANTHA.

For the opportunity of figuring this charming novelty we are indebted to Mr. Ch. Lorenz, of Erfurt.

SAINTPAULIA IONANTHA.

The plant combines in itself the appearance of a streptocarpus, a ramondia, and a gloxinia, it is a member of the large gesneracious family, and its flowers somewhat resemble a violet in form and color. Saintpaulia Ionantha was found on the Usambara Mountains, in East Central Africa, by Mr. Saintpaul Illaire, and will doubtless become popular, as many British firms are this season offering seed of it. This novelty requires similar treatment to that under which the beautiful streptocarpus thrives. The foliage is like that of a gloxinia, but smaller and very stout. The whole plant is dwarf, and flowers uninterruptedly the whole year through. The flowers are borne freely on short stalks, are dark blue or violet in color, but are rounder in outline, and flatter than those of Viola odorata. The fineness of the seed renders it necessary to warn intending purchasers to handle the packets carefully; sow the seed thinly, having previously watered the soil.

LOBELIAS.

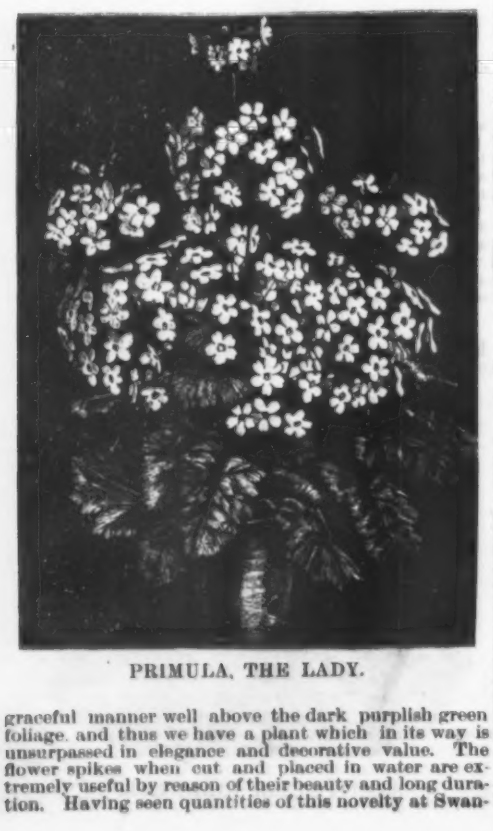
Several new lobelias, varieties suitable for bedding purposes, have been brought forward this year. The finest and most distinct of these is doubtless Barnard's Perpetual, which has been described as the "finest lobelia yet raised." We give an illustration of this excellent novelty, of which Mr. William Bull, King's Road, Chelsea, holds the entire stock; the color is brilliant blue, with a patch of pure white at the base

LOBELIA, BARNARD'S PERPETUAL.

of the two lower petals, and the habit of the plant is all that can be desired. We have seen this on several occasions and can speak well of it. Messrs. W. Clibran & Co. include Golden Queen in their list of novelties. This is an effective golden foliaged variety, with pretty dark blue flowers. A distinct pure white flowered lobelia named White Ladie is in the hands of Messrs. H. Cannell & Sons. It is the result of many years' selection, and in everything save color is similar to the celebrated Crystal Palace Blue; White Ladie is stated to come true from seed, and this being the case, it will be eagerly sought after by those who have to propagate large stocks of white lobelias.

PRIMULAS.

Messrs. H. Cannel! & Sons have a novelty of great merit and distinction in The Lady. This is a single white flowered form with yellow eyes to the blooms; the latter are borne in wondrous profusion in whorls, and these are freely produced, holding themselves in a

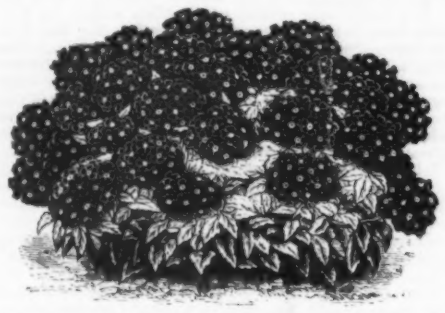


PRIMULA, THE LADY.

graceful manner well above the dark purplish green foliage, and thus we have a plant which in its way is unsurpassed in elegance and decorative value. The flower spikes when cut and placed in water are extremely useful by reason of their beauty and long duration. Having seen quantities of this novelty at Swanley, we do not hesitate to say that The Lady will commend herself to those of æsthetic tastes. Cannell's Eynsford White is remarkable for the purity of its whiteness, while the fimbriation of the overlapping petals is not equaled by any known form. Cannell's White is also a good single white, holding its flowers well above the foliage. The new single primula Snowflake, offered by Messrs. J. Veitch & Sons, Chelsea, is a valuable novelty; it is dwarf in habit, has fern-like foliage, while the flowers are handsomely fringed, of snowy whiteness, and have the smallest of yellow eyes.

VERBENAS.

These beautiful plants have apparently lost favor in the southern districts, and their successful cultivation has largely become a lost art. The amount of time expended upon beds planted with verbenas in years that



VERBENA COMPACTA COCCINEA OCULATA.

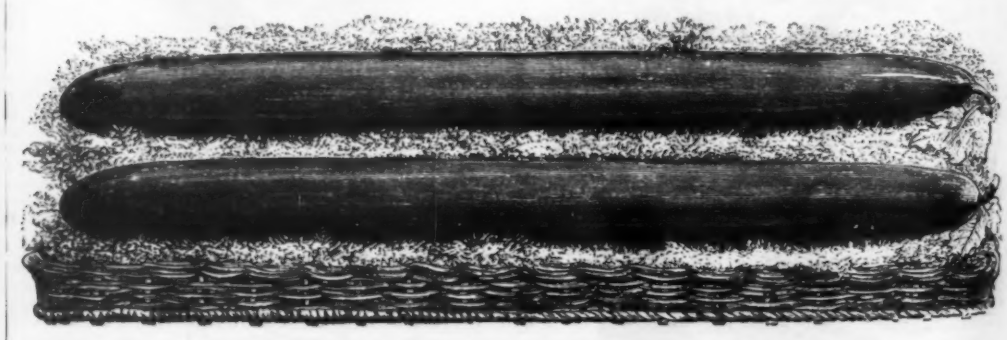
have long since past in pegging and training into order the trailing and straggling shoots will be remembered by many. Such time would have been saved and verbena pins would have been unnecessary had we but known such handsome forms as that illustrated as Verbena compacta coccinea oculata. We are indebted to Mr. W. Bull for the opportunity of figuring this novelty, the length of whose name might be disastrous were it not expressive. The compact habit is well shown, and it only remains for us to say that the flowers borne in large trusses are bright scarlet, with a large white eye.

ZINNIAS.

Given a good selection of seed, careful raising so as to avoid spindly growth, a well drained soil and a bright summer, then zinnias in any garden cannot be outdone for striking effect, neither are they excelled in brilliancy and gorgeousness of coloring by any other subject, not excepting the dahlias. Mr. William Bull offers improved zinnias of enlarged size and excellent shape; when the sun is shining upon the living flowers the latter present a dazzling combination of scarlet and gold, and these colors so elegantly mixed have suggested the name of the variety—Scarlet and Gold. When we remember that zinnias vary so largely it is worthy of note that this variety has been so far fixed that about seventy per cent. are said to come true from seed. Zinnia beds should always be well drained and the soil light and rich, otherwise much disappointment will follow. Messrs. H. Cannell & Sons are offering seed of the wonderfully fantastic Curled and Crested zinnias, which were introduced by Messrs. Peter Henderson & Co., of New York; these in their various colors, and also the diminutive Lilliput, with its interesting compact heads, are in every sense of the word novel.

CUCUMBERS.

The remarkable extension which cucumber culture has undergone of late years has quickened the activity of raisers, and as the result, important additions to the lists are made from time to time. Chief among the most recent introductions are: Bountiful, a remarkably fine variety, equally suitable for exhibition and the table; and Stourbridge Gem, a distinct variety of great excellence, being immensely productive, of high quality and very handsome. Both have been introduced by Messrs. E. Webb & Sons, and promise to attain a high degree of popularity. Sutton's Peerless is distinguished by its productiveness and handsome appearance, and is unsurpassed in delicacy of flavor. The

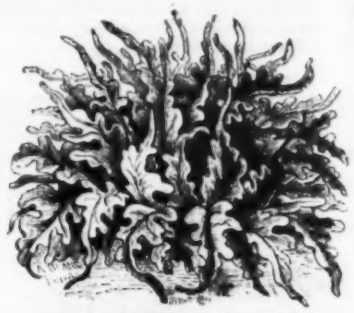


CUCUMBER, STOURBRIDGE GEM.

fruits, under good cultivation, attain a length ranging from twenty-four to twenty-eight inches, are perfectly straight and with short neck.

LETTUCE.

Our attention has been drawn to a distinct novelty in this vegetable, namely, the Oak-Leaved Lettuce, which is being offered by Messrs. W. Clibran & Son, Manchester and Altrincham. The illustration will convey to the reader a very good idea of the general appearance of this new comer. The shape of the leaves fully justifies the name of the variety, and this peculiarity does not detract from its usefulness. The Oak-Leaved Lettuce has a fine flavor, forms an early growth and stands well. Large Yellow Market is a new cabbage variety of considerable merit, inasmuch as its compact heads are unaffected by bad weather, while tenderness and flavor are all that can be desired. Messrs. J. Veitch & Sons have an excellent variety, Golden Queen, a pretty cabbage form with crisp golden

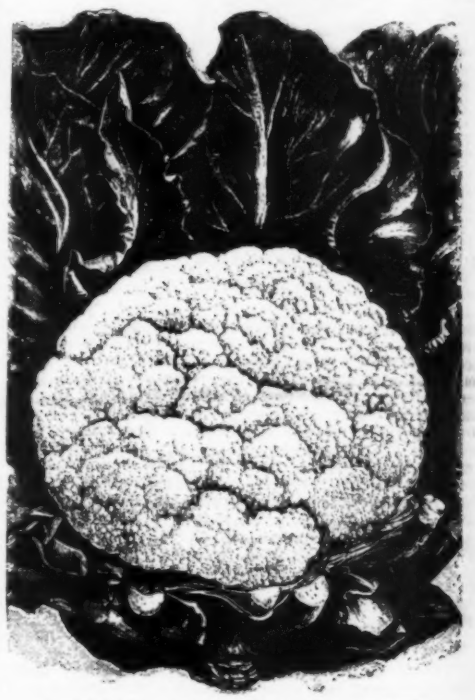


OAK-LEAVED LETTUCE.

leaves, which was certificated at one of the Royal Horticultural Society's meetings.

BROCCOLIS.

The improvement of these vegetables proceeds so slowly that really good additions are well deserving of a hearty welcome. Avalanche, raised and introduced by Messrs. E. Webb & Sons, is especially promising, for with finely formed, pure white, delicately flavored heads is combined a degree of hardiness considerably above the average. Sutton's Snow White is a most valuable addition to the varieties in use during the



BROCCOLI, SUTTON'S SNOW-WHITE.

spring months. The heads are of good size, firm, pure white, and exceptionally delicate in flavor. The accompanying illustration renders a lengthy description of this fine novelty unnecessary.

MELONS.

As the result of the comparative facility with which new melons can be raised, many novelties are presented to the public notice annually; but in consequence of raisers failing, as a rule, to thoroughly test their seedlings before submitting them to the Fruit Committee of the R. H. S. and other bodies, very few are found to possess sufficient merit to justify their being considered worthy of general cultivation. Among the few that have passed muster and are offered this season are some of exceptional excellence, and to these we shall briefly direct attention. Sutton's Scarlet and Windsor Castle, introduced by Messrs. Sutton & Sons, are noteworthy additions to the list. The first mentioned is a scarlet flesh variety raised by Mr. Tegg, of Bearwood, and has globular finely netted fruits of a rich golden hue and with deep red flesh, remarkable for its richness of flavor. Windsor Castle is a very dis-

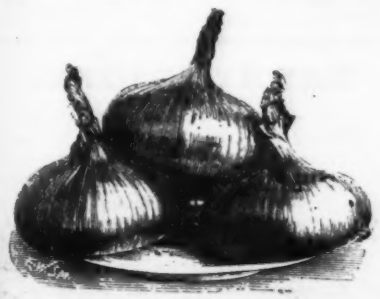
tinct green flesh variety, fruits large oval in form with netted skin; the skin is deep green, rich and luscious. Beauty of Syon, introduced by Messrs. J. Veitch & Sons, was raised by Mr. G. Wythes, the able chief of the Syon House Gardens, and is a very valuable addition to the scarlet flesh varieties. The fruits are globular, with finely golden yellow skin, and the flesh is bright in color and rich in flavor. As indicating its high quality it may be mentioned that the variety was awarded a first-class certificate by the Fruit Committee of R. H. S. at the end of October, when, generally speaking, melons are not at their best. As shown by

MELON, BEAUTY OF SYON.

the illustration of a plant grown by Mr. Wythes, Beauty of Syon is well adapted for pot culture. Frogmore Seedling, also introduced by Messrs. Veitch, was raised by Mr. Owen Thomas, the Royal Gardens, Frogmore, and is a valuable addition to the white flesh section. The fruit is of medium size, has a yellow slightly netted skin and a white flesh, which is exceptionally thick and richly flavored. President, introduced by Messrs. E. Webb & Sons, is another white flesh melon of exceptional excellence. The fruits are of large size, oval in form, and the flesh is white, firm, rich and luscious. The plant has a good constitution and sets its fruits freely.

ONIONS.

Of late several improved types have been introduced, and as, without exception, they have a tendency to the globular form, we have an indication that raisers are beginning to appreciate the superiority of the globe to the flat types, because of the greater bulk obtained from a given area. One of the most important of the novelties is Sutton's A1, which stood high in the Chiswick trials last year, and obtained the distinction of three marks (× × ×), and was awarded a first-class certificate by Fruit Committee of R. H. S. in the autumn. The bulbs are semi-globular in form, handsome, very solid, and have a brownish skin, while the quality is very high. Veitch's Main Crop is a handsome onion, high at the shoulders and full at the base, and very heavy in proportion to its diameter.



ONION, "SANDY PRIZE" WHITE SPANISH.

The skin is of a pale straw color, and the quality good. As indicating the weight of the bulbs, it is of interest that Mr. J. Channery obtained twenty-five cwt. from 104 square yards, and that Mr. E. F. Crocker reports a crop of 2,008 pounds from five perches. Laxton's Sandy Prize is an excellent form of the White Spanish, selected by Messrs. Laxton Brothers, and has fullness both at the shoulders and the base. Southport Red Globe and Southport Yellow Globe are two extremely useful globular onions that promise to prove exceedingly useful for market supplies, as well as for the garden. In comparison with the best of the flat forms of the Blood Red onion, Southport Red Globe weighed, we found, exactly twenty-five per cent. heavier, a point of enormous importance to the grower for market. Cocoa Nut is an excellent addition to the globe-shaped onions, the skin yellowish green, and the bulbs remarkable for their solidity. The last three have been introduced by Mr. Deverill, and received awards of merit from the Fruit Committee of R. H. S. in the autumn.

POTATOES.

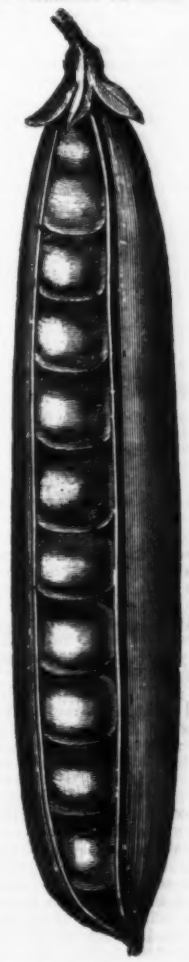
Prominent among the potatoes which had first-class certificates conferred upon them by the Royal Horticultural Society last year after trial at Chiswick is Jeanie Deans, a second early round introduced by Messrs. J. Carter & Co. The variety belongs to the second early section, and is a very heavy cropper. The tubers are large, round, or pebble-shaped, with a netted skin and white flesh, which is dry and floury when cooked; it should prove a good market variety. Fidler's Colossal, raised by Mr. Fidler, is a heavy cropper, and the tubers are large, long, and with rather rough skin; the quality when cooked is very high. Conference, raised by Mr. R. Dean, is a valuable main crop variety, the tubers pebble-shaped, with red eyes, and of high quality. Triumph and Windsor Castle, two valuable varieties raised by Messrs. Sutton &

POTATO, JEANIE DEANS.

Sons, were also certificated by R. H. S. after trial at Chiswick. The first named is a main crop variety, with rather long pebble-shaped tubers, which have a rather rough skin, and are of the finest flavor cooked. The second has a short, erect habit, and produces handsome tubers of an elongated pebble shape. Like Triumph, it is a heavy cropper and of excellent quality. Success, a white kidney sent to Chiswick by Mr. J. Aplin; Nellie Langtry, a pebble-shaped variety with yellow flesh, raised by Mr. H. Fletcher; Major T. Neve, a roundish white kidney, raised by Mr. H. Fincham, all of which received first-class certificates after trial at Chiswick, are deserving the attention of cultivators. Early Regent and Sharpe's Victor, which also obtained distinction from R. H. S. last year, are now so well known as not to require description.

PEAS.

Several noteworthy additions to both early and late peas have been made of late. The best of these comprise Sutton's May Queen, a distinct marrowfat pea, productive, and of high quality, and as early as Ringleader. This has been introduced by Messrs. Sutton & Sons, and was raised by Mr. Culverwell



PEA, GRADUS.

from a cross effected between American Wonder and Early Paragon; the height is about 30 inches. Sutton's Eureka is a valuable addition to the main crop varieties. The variety is robust in growth, immensely productive, the pods large, handsome, and well filled, and the peas bright green and finely flavored; the height is three feet. Very valuable also is Laxton's Gradus, a distinct wrinkled marrow, raised by Messrs. Laxton Brothers, of Bedford, which should prove of a high degree of utility. It is equal in earliness to William I., while the pods are as large and well filled as those of Duke of Albany, and the peas are large, bright green, and well flavored. Alderman, also raised by the Messrs. Laxton, is a promising main crop variety; it has strong, free branching habit, is immensely productive, and the pods are of the largest size and well filled. Each of the Bedford varieties has obtained the highest distinction from the Royal Horticultural Society after trial. Senator, raised by Messrs. Webb & Sons, and sent out for the first time last season, proved so exceptionally good that mention might with advantage be made of it. It attains a height of between thirty inches and three feet, and bears a profusion of curved, well filled pods. This promises to prove of much value for garden culture, as well as for the private garden. Veitch's Main Crop, introduced by Messrs. J. Veitch & Sons, is a valuable addition to the mid-season wrinkled marrows. The haulm attains a height of three feet, is robust and free branching, and the large, slightly curved pods are well filled, and the peas bright in color and of excellent flavor. It is one of the heaviest cropping varieties that has yet come under our notice.

## IRRIGATION BY THE USE OF WINDMILLS.

By R. A. MCALLESTER, Land Commissioner of the Union Pacific Railway.

AT the Interstate Irrigation Convention, held at Salina, Kan., on September 28, 1893, my attention was particularly drawn to the subject of pumping water for irrigation by means of windmill pumps. Several gentlemen were present from Garden City, Kan., who detailed, in a very interesting way, the results obtained in their locality by this means. Shortly afterward, in conversation with a gentleman from Julesburg, Col., I learned that one or two farms were being irrigated in the same manner in the vicinity of Julesburg.

It then became a matter of curiosity to ascertain the extent to which this irrigation, by pumping, has been practiced throughout the country, and I prepared and sent to each of our station agents and land agents in Nebraska, west of North Platte; Kansas, west of Wa Keeney; Wyoming, east and south of Cheyenne; and all of our agents in Colorado, New Mexico and Texas, a circular letter asking the names and addresses of any individuals whom they might know were pumping water for irrigation purposes. In response to these letters I secured in the neighborhood of two hundred names of parties located in western Nebraska, southeastern Wyoming, northeastern and east central Colorado and western Kansas. To each one of those parties I sent a letter asking the locality of their lands, number of acres irrigated, power used, whether wind or steam, cost of plant and cost per year of operation; depth and diameter of well, depth of water, whether or not the well could be pumped dry; diameter of stream coming from the pump, capacity of pump in gallons per hour, average length of time per year of running the pump and area and depth of reservoir. A large number of these letters have been returned with full and complete answers to the questions asked, and in many instances accompanied by enthusiastic letters advocating this method of irrigation.

While awaiting replies to these letters to the individual farmers, I submitted to one of the prominent wind engine pump companies a series of questions as to the capacity, cost, etc., of windmills and pumps. From the pump company I learned that one horse power will raise a 5 in. column of water 100 ft., a 6 in. column 70 ft. and an 8 in. column 40 ft.; additional horse power will elevate the water in direct proportion. A 10 ft. mill will develop one-half of one horse power; a 12 ft. mill three-fourths horse power; a 14 ft. mill two horse power, and each additional two ft. in diameter of mill develops practically an additional horse power up to a 30 ft. mill, which develops 8 horse power. The cost of the mills ranges from $40 for the smallest size to $400 for the largest.

In response to an inquiry as to the estimated number of days a windmill will run during the year, the company replies as follows: "It depends on locality. Here in Illinois total output one-third or eight hours per day. Kansas and Nebraska will average double this amount." I think the estimated average for Kansas and Nebraska, as compared with Illinois, will be accepted without question.

I further ascertained from the pump company that a 5 in. pump geared to run forty-eight 8 in. strokes per second will discharge 1,860 gallons of water per hour; a 6 in. pump geared in the same way will discharge 2,760 gallons per hour, and an 8 in. pump will discharge 4,860 gallons per hour.

THE DUTY OF WATER.

From the printed report of the Colorado State Agricultural College, at Fort Collins, Col., I learned that the duty of water, as determined by actual measurement is one cubic ft. per second running continuously for sixty to sixty-five acres of ground. This during the month of June, when the greatest amount of water is needed for irrigation. During the entire irrigation season one cubic ft. per second, if reservoired, is sufficient for 175 to 300 acres. The same report shows that by actual measurement the amount of water required for various crops ranges from 1·67 ft. to 2·53 ft. in depth. That is, if the entire amount of water necessary for the perfect irrigation of the land were applied to the land at one time, it would be necessary to cover the ground to the depth named, according to the crop to be irrigated. The report shows also that this measured depth includes the measured rainfall during the same season. For the purpose of estimates given in this paper, I will assume that the average depth required for crops is two feet.

WHAT A WINDMILL WILL DO.

From the statements made by the pump company as to the capacity of a pump, I learn that a 5 in. pump will discharge 1,860 gallons of water per hour. This is 31 gallons per minute or five-tenths gallons per second, and is equal to 0·06⅔ cubic ft. per second. On the Colorado basis, as before given, a stream running 0·06⅔ cubic ft. per second would irrigate about six acres of land; but the pump is only estimated to run about

one-third of the time, consequently one-third of the water would be secured and about two acres could be irrigated direct from the pump.

I have a large number of reports from farmers who apparently put in their windmills originally for the sole purpose of securing water for stock, but have since been successfully irrigating orchards, garden patches, etc., from the surplus water without making any attempt to reservoir it. These reports show that such surplus water is sufficient to irrigate from one to three acres of land.

Now, suppose a farmer expends a few dollars in constructing a reservoir 100 ft. square by four ft. deep, what would be the result? Such a reservoir will contain 40,000 cubic ft. or about 300,000 gallons of water. A 5 in. pump discharging 1,860 gallons of water per hour will, in one-third of a day, or eight hours, discharge 14,880 gallons. In twenty days of eight hours each (this is assuming that the windmill runs one-third of the time) 297,600 gallons of water will be secured, practically filling our 300,000 gallon reservoir. During the six months from April to September inclusive, there are nine periods of twenty days each; therefore, the reservoir can be emptied and filled nine times during the six months, resulting in an aggregate of 2,700,000 gallons of water for irrigation purposes, equal to 360,000 cubic ft.

The report of the Kansas State Board of Agriculture for last year shows that at Wallace, Kan., during the six months from April to September, the rainfall aggregated over fifteen in. We have before found that an average of two ft. in depth, including the rainfall, is required for practical irrigation; or in other words, two cubic ft. of water per square ft. of land. An acre of land contains 43,560 square ft.; therefore, to irrigate one acre of land requires 87,120 cubic ft. of water; of this ¼ or ⅓ may be estimated as being the rainfall, leaving ⅔ to be supplied from the reservoir. Therefore, to irrigate one acre of land during the season requires 32,670 cubic ft. of water; but our pump and reservoir will supply during the season 360,000 cubic ft., or water enough to irrigate about eleven acres.

Now, we have seen what in theory ought to be accomplished with a pump and reservoir of the capacity named; let us see what our farmer's reports show as actually being accomplished. John Simon, of Garden City, Kan., reports a windmill pumping a 5 in. stream of water into a reservoir 100 ft. square by 4 ft. deep, raising the water 13 to 15 ft. and irrigating 10 to 15 acres; the entire cost of his plant was $140, with practically no outlay for operating expenses. J. F. Monson, of Julesburg, Col., reports that he is irrigating 8 to 10 acres with two windmills raising a 3 in. stream of water 20 ft. into a reservoir 80 ft. in diameter and 4½ ft. deep. The cost of his plant was $225. J. L. Diesem, of Garden City, Kan., is irrigating 15 acres from a well 13 ft. deep, by means of a pump throwing 6,000 gallons per hour into a reservoir 140 ft. by 153 ft. and 4½ ft. deep. His plant cost $350. Examples of these results might be multiplied indefinitely; but enough have been given to show that theory and practice bear one another out, and that, at a comparatively moderate cost, it is eminently practicable to irrigate 10 to 15 acres of land by means of a windmill pump.

### DEPTH OF WELLS.

Another important question to be considered in this connection is the depth from which water can be successfully pumped by windmills for irrigation. Theoretically, a 5 in. column of water can be raised 100 ft. for each horse power developed by the windmill. The pump company states that the practical limit of raising water is about 200 or 250 ft. Among the reports which I have received from the farmers I have a number of instances where the water is being pumped from considerable depths. Among them J. C. Houser, of Grainfield, Kan., is pumping from a well 56 ft. deep. S. K. Wine, of Menlo, Kan., is pumping from a well 130 ft. deep. S. T. Percell, of Grainfield, Kan., is pumping from a well 140 ft. deep. Four wells at Weskan, Kan., are respectively 135 ft., 153 ft., 160 ft. and 140 ft. in depth. This shows that it is practicable to raise the water from a considerable depth below the surface of the ground.

### INDEPENDENCE ON FEW ACRES.

It is my opinion that the future irrigation of the plains country is to be largely carried on by means of windmill pumps. Each farmer can, independent of his neighbors or of any irrigation company, and at a cost not exceeding $250 irrigate from 10 to 15 acres of his quarter section, and 10 to 15 acres properly irrigated and carefully cultivated is as much as any man ought to undertake to cultivate under irrigation. On this irrigated ground he can raise those crops which will bring in the best financial returns, and can thereby insure himself and his family sufficient income to more than support them independent of the fluctuations of the natural rainfall. On the remaining portion of his 160 acres he can raise by dry farming the same crops in character and amount as he is now getting, and two years out of three he is bound to get magnificent crops from the non-irrigated land.

### EFFECT UPON CLIMATE.

I am further convinced that if ten acres out of each quarter section of the plains country were irrigated the resultant evaporation from the necessary reservoirs and from the irrigated land would so disturb the existing climatic conditions that the long droughts which are now liable to be experienced would be permanently broken up, and that the average annual rainfall, instead of coming at infrequent periods and in heavy driving storms, always causing more or less damage, would be obtained at frequent intervals and in the shape of gentle rains which would do the greatest amount of good. The result would be that from the non-irrigated land would be obtained each and every year fully as good crops as were obtained in western Kansas and Nebraska in 1891 and 1892.—*Irrigation Age.*

---

[FROM THE KANSAS CITY TIMES.]

## VISITING A CHINESE PATIENT.

THE appended letter was written to a relative in Kansas City by a young lady, an M. D., who was sent by the Presbyterian Board of Foreign Missions, of New York, to take charge of a hospital at Chin Nan Foo, China. She writes of her reception by one of the dignitaries there:

CHIN NAN FOO, Oct. 20.

DEAR DONAS: I have something very interesting to tell you this time. The great high official of the province sent a message with a present for the foreign doctor and a request, or rather an invitation, to come and see his Taitai, *i. e.*, his wife, who was sick with a skin disease. After we had accepted the invitation and the present the official runner or messenger returned to the official with the word that the present was accepted. Then the messenger returned to ask the foreign doctor when it would be convenient for her to use the chairs and servants the official would send. The messenger returned to the official with the message when the doctor would arrive.

As I could not talk Chinese yet, Mrs. Neal had to go with me, and so she dressed herself up in perfect Chinese style from head to foot, wearing the most beautiful silk garments and a gorgeous pair of shoes made for unbound Chinese feet. I borrowed some elegant clothes of one of the missionaries, and we two made-up Chinese women, escorted by our female servant, who likewise was finely dressed, got into the sedan chairs the official had sent. And this is the way the procession went: Ahead walked two official runners, then Mrs. Neal's chair, carried by two men (on their shoulders); on one side of her chair marched a man servant. Then came my chair, carried by two men, and at my side a man servant; then behind me our woman servant on a wheelbarrow.

We went through street after street until we came to an immense open courtyard. Entering this, we passed through a high gate, which was swung open by the gatekeepers at our approach; then we were in another court, which was lined on either side by houses in which the official servants lived. Passing on we entered a second gate, which took us into the second court, and so on until we had passed through eight gates and courts. Each gate swung open in this ceremonious style, and each court containing a number of servants' houses opening into it.

When we finally reached the fourth court there appeared several servants to assist us out of the chairs and up the stairs. Then passing over the threshold (which is a foot high and the most awkward thing to get over you ever saw), we found ourselves face to face with the Taitai in a large hall. At the Taitai's side stood a young woman, daughter of one of the official's wives. Behind them stood a train of about twelve servant women. The Taitai folded her hands and bowed, and Mrs. Neal did the same, shaking her folded hands the same number of times the Taitai did, and bowing just as low. Then I did the same.

Then the young woman went through the same performance, and I was introduced as U. Difer, and the bowing was repeated. Then we followed the two ladies into the adjoining room, and the Taitai said she did not know whether to give the high seat of honor on her left to me or Mrs. Neal, but Mrs. Neal insisted that I should have it; so I sat down on the left hand side of the table, and across the room was a similar table, on either side of which sat the two next women in rank. Mrs. Neal sat to my left and the servants stood around, filling the room. Tea was served immediately; then all kinds of fruits, peaches, pears, etc., and, by the way, these were cut crosswise, the fruit in very thin slices, and dealt out by chop sticks of ivory. The young lady served the food. Everything is prepared ready to eat on a Chinese table. They think our way of pulling at food with knives and forks is very funny. Then various cakes and drinks, and, strange to say, these little knicknacks we have at home, and the letters H. P. printed on each was an enigma to the Taitai, and she asked us what it meant. Mrs. Neal pronounced the letters and said they were the initials of the manufacturer. They thought it was very queer. The last course was dumplings stuffed with garlic; this we refused politely.

The Chinese always begin at the wrong end of the menu, according to our thinking; and certainly their poor digestion shows the indiscretion of calling on the stomach to digest sweetmeats and nuts first and soup last. Mrs. Neal and the Taitai carried on a lively conversation, which consisted largely of personal remarks and one insisting on the other to eat. It is impolite to touch anything until a lot of red tape has been been gone through four times.

Mrs. Neal said I would examine her skin if it was convenient, but every time the Taitai would say, "Oh, no, no hurry; rest and eat longer." She could not get over the fact that I couldn't talk Chinese; it seemed beyond her comprehension that I could not say what she could say. I used a few phrases I had picked up to the best of my advantage, but the rest of the time I felt very awkward. There is nothing can equal the awkwardness one feels in being among people whose language you do not understand. It is just distracting; your mouth fills with words, but your tongue is paralyzed.

Well, finally we got to the professional part of my call and the Taitai (that is pronounced like ti ti, with a long sound of i) took a seat near the window and I examined her face; then she threw up her sleeve and bared her arm, and I took a Chinese arm in my hand for the first time. As I did this she remarked that our skin was so much finer and whiter than hers. As I wished to see her chest she escorted us into an adjoining room and undid her garments. After asking several questions I said I would send some medicine, for I was satisfied with my diagnosis. After resting a little longer the chair bearers were called and the servants assembled; then came the bows and shaking of hands. They fold their hands and move them together up and down several times, according to the honor they wish to bestow, then bow lowly; men touch the ground to show much honor. I have had many of them give one sweep of the body and touch the ground before me. It is very strange to one at first.

Well, we bowed ourselves out and a woman servant escorted us by the hand to our closed sedan chairs (lined with silk curtains), then the men servants stepped up and closed down the front curtains at the entrance to the chairs. Then the chairs were raised by the long poles and put on the men's shoulders and we went back in all the glory in which we came.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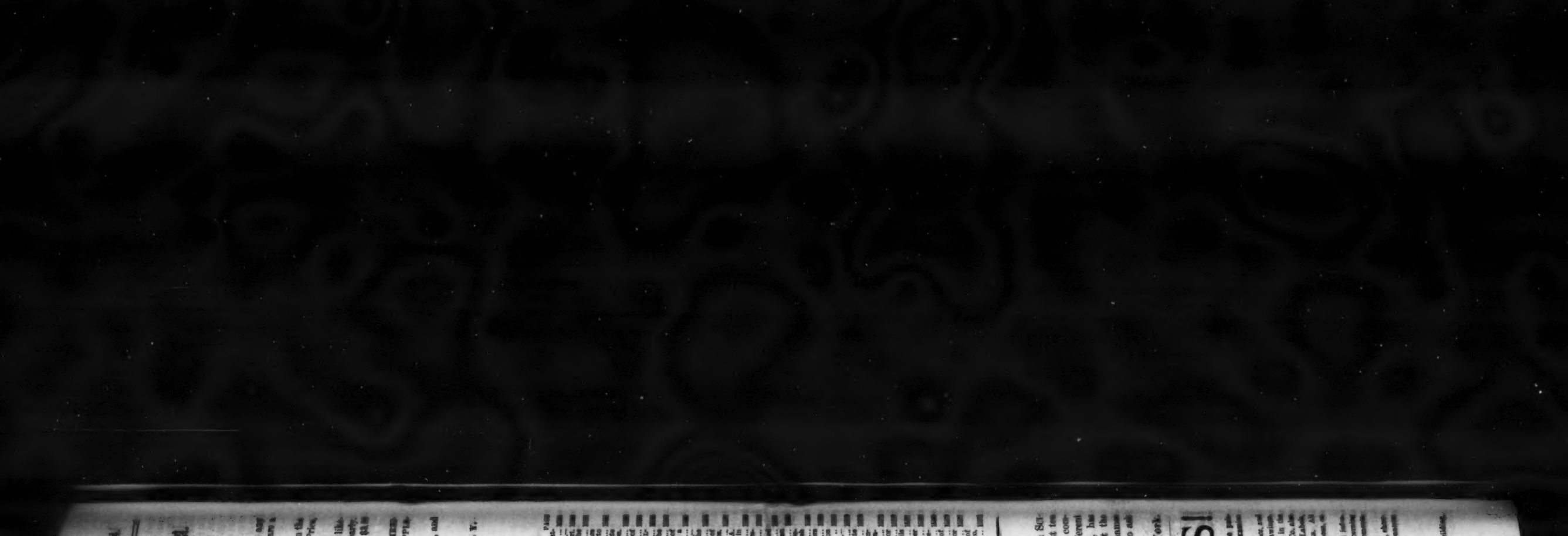
BRANCH OFFICES.—Nos. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.